CONTRIBUTION OF SMALLHOLDER MAIZE PRODUCTION TOWARDS HOUSEHOLD FOOD SECURITY IN BABATI DISTRICT

By

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A Dissertation Submitted in Partial Fulfilment of Requirements for Award of the Degree of Master of Science in Project Planning and Management of Mzumbe University

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CERTIFICATION

We, the undersigned, certify that we have read and hereby recommend for acceptance by the Mzumbe University, a dissertation entitled **Contribution of Smallholder Maize Production towards Household Food Security in Babati District,** in partial fulfilment of the requirements for award of the degree of Master of Science in Project Planning and Management of Mzumbe University.

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I James Peter Ngurumwa, declare that this is my own original work and that it has not been presented and will not be presented to any other university for a similar or any other degree award.

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Date_____

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May God bless them all abundantly!

DEDICATION

I dedicate this work to my beloved parents Mr. and Mrs. Bishop Peter Ngurumwa who have been so inspirational to me throughout my life. I appreciate their decisive role in nurturing me; their prayers to me, encouragement and support.

LIST OF ABBREVIATIONS AND ACRONYMS

AE	Adult Equivalent
AusAID	Australian Aid
BRN	Big Result Now
CBOs	Community Based Organisations
DD	Dietary Diversity
DEC	Dietary Energy Consumption
DES	Dietary Energy Supply
ECDPM	European Centre for Development Policy Management
ESA	Eastern and Southern Africa
ESRF	Economic and Social Research Foundation
FAO	Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistics
FGD	Focus Group Discussion
FHHs	Female-Headed Households
GDP	Gross Domestic Product
GFSI	Global Food Security Index
GHI	Global Hunger Index
GOT	Government of Tanzania
HCA	Household Caloric Acquisition
HDDS	Household Dietary Diversity Score
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGC	International Grain Council
MAFC	Ministry of Agriculture Food Security and Cooperatives
MALF	Ministry of Agriculture Livestock and Fisheries
MDGs	Millennium Development Goals
MHHs	Male-Headed Households
NGOs	Non-Governmental Organisations

NMRP	National Maize Research Program
PCE	Private Consumption Expenditure
REPOA	Research on Poverty Alleviation
ROI	Return on Investment
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
Tshs	Tanzania Shillings
UN	United Nations
URT	United Republic of Tanzania
USA	United States of America
WCA	Western and Central Africa
WEMA	Water Efficient Maize for Africa

ABSTRACT

The main objective of the study was to analyse the contribution of smallholder maize production towards household food security in Babati District. Specific objectives were to examine household maize production per year in Babati; to examine household caloric acquisition from maize consumption; and to investigate the challenges facing maize producers. Primary data was collected from 80 households through observation, interview and focus group discussion using structured questionnaire and checklist. The study found that the average maize yield was 509.72 kg/acre. Farmers incurred an average production cost of 118,642.29 Tshs per acre that was dominated (42%) by ploughing. Also, farmers accrued an average of 254,860.69 Tshs per acre with an average Return on Investment of 44.1%. Almost all (i.e 96.25%) of the households in the study area had three meals per day and about 79.2% (1770.1 kcal/adult equivalent/day) of caloric intake per adult equivalent per day was acquired from maize. Basing on Dietary Energy Consumed per adult equivalent per day, 53.75% and 46.25% of households were food secure and insecure respectively; however, basing on Household Dietary Diversity Score, 73% and 7% of households were food insecure and secure respectively. Three quarters (70%) of households had at least one individual involved in non-farm activities. Majority (33.75%) accrued an average income of between 100,001 and 200,000 TSHS per month. Moreover, majority (32.5%) of households responded that low income among maize producing households was the major constraint in maize production; other challenges were unreliable rainfall, high cost of hybrid maize seeds, inadequate ploughing tools, wild animals and theft of crops. Hence, households should expand their farming systems to include the cultivation of vegetables, legumes and tubers. Also, they should diversify farm income to other off-farm activities such as business or any small enterprise so as to be able to improve their dietary intake as well as ensuring financial liquidity at the household that can help them to manage farm activities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER ONE

BACKGROUND INFORMATION

1.1 Overview

This study aimed to investigate smallholder maize production towards household food security. So, this chapter presents the background information relevant to the study, a statement of the problem, research objectives, research questions and significance of the study.

1.2 Background of the Study

The meaning of food security has experienced a significant evolution throughout the years, moving from a supply-focused concept, mostly related to food availability, to a multidimensional notion to consider also food accessibility, food utilization and food stability (Pieters *et al.,* 2012). The concept of food security was first originated in the mid-1970s, when the World Food Conference (1974) defined food security in terms of food supply - assuring the availability and price stability of basic foodstuffs at the international and national level. In 1983, Food and Agriculture Organization of the United Nations analysis focused on food access, leading to a definition based on the balance between the demand and supply side of the food security equation. Later on in 1986, the definition was revised to include the individual and household level, in addition to the regional and national level of aggregation, in food security analysis. Therefore, the concept of food security was defined in the World Food Summit (1996) to include food access, availability, food use and stability (FAO, 2006). Generally, food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2008). From this definition, four main dimensions of food security can be identified and which are physical availability of food, economic and physical access to food, food utilization and stability.

Food availability is the physical availability of food, and it is determined by local production of food, importations of food and/or donations (aid) (Opara, 2013). At

household level, food availability is when sufficient quantity and quality of food is present in local markets and shops (Pieters *et al.*, 2013). Availability is achieved if adequate food is ready to have at people's disposal (Gross *et al.,* 2000). Food accessibility is the physical access of food in the market and economic access at the household level (household purchasing power) (Opara, 2013; FAO, 2008). A household can access food if it has the opportunity to obtain food of sufficient quantity and quality for a safe and nutritious diet (Pieters *et al.,* 2013). The level of household income is a key determinant of a household's ability to spend on food which also measures household's food accessibility (Opara, 2013). Food access for urban dwellers, hinges primarily on the household's ability to purchase food whereas for rural dwellers, food access rely highly on household's food production though in some instances may depend on household's ability to purchase food (Muhihi *et al.,* 2012). However, every household has a limited amount of resources at its disposal, including assets, labour, human capital, and natural resources. The allocation of these resources to food production, wage labour or other business activities allows the household to access food, either directly through food production or indirectly through income generation (Pieters *et al.,* 2013). Food utilization is considered the key factor of food security and it relates to an individual's dietary intake and his/her ability to absorb nutrients contained in the food consumed (Pieters *et al.* 2013; Opara, 2013). It is the way in which the body acquire various nutrients from the consumption of food (basing on quantity and quality) that is enough to meet the caloric (energy) and nutrient requirements (Opara, 2013). The consumption of adequate calories and nutrients by individuals in a household is influenced by food preparation, feeding practices, food diversity and intra household distribution of food (like for children and adults) (FAO, 2008). Stability means the balance of the other three dimensions over time. Even if household's food intake is adequate today, they are still considered to be food insecure if they have inadequate access to food on a periodic basis, risking a deterioration of their nutritional status (FAO, 2008).

Availability, accessibility, utilization of food and the stability of these three elements differ in their nature, causes and effects at the macro, meso and micro level (Gross *et al.*, 2000). For example, food may be available in a country but not in certain disadvantaged districts or among discriminated population groups. Also, the seasonality of food availability and utilization, due to cyclic appearance of diseases, may be a rural but not an urban phenomenon (Gross *et al.*, 2000).

Food security at national level refers to the condition whereby the nation is able to manufacture, import, retain and sustain food needed to support its population with minimum per capita nutritional standards (Toit *et al.,* 2011). At community level food security is defined as the condition whereby the residents in a community can obtain safe, culturally accepted, nutritionally adequate diets through a sustainable system that maximizes community self-reliance. At household level food security refers to the availability of food in one's home which one has access to. In this case, a household is regarded as food secure when the members of the family do not live in hunger or fear of starvation (Toit *et al.,* 2011).

In many parts of the world and especially in developing countries, agriculture is a key to food security (Toit e*t al.,* 2011). Hence, investing in agriculture is essential to improve food security for the majority of the world's poor, who rely directly on agriculture for subsistence (AusAID, 2011). Maize, wheat and rice are the three major cereal crops that not only produced but also feed the world (Karim and Rahman 2015). For the year 2015/16 the world production of maize, wheat and rice was estimated to be 969 million tonnes, 736 million tonnes and 473 million tonnes respectively; and the consumption was estimated to be 719 million tonnes, 972 million tonnes and 483 million tonnes for wheat, maize and rice respectively (International Grain Council 2016). Despite the production of wheat, rice and other cereals, maize accounts for 36.5% of total cereal production in the world. In many countries of Sub-Saharan Africa (SSA), maize is the major staple crop which is cultivated in nearly 34 million hectares (36% of the total area planted with cereals). Its consumption ranges from 52 to 328 grams/capita/day. In East

Africa, maize accounts for 33.6% of total area planted with cereals (FAOSTAT, 2015; Ranum *et al.,* 2014; Cairns *et al.,* 2013).

In Tanzania, majority of households are engaged in small-scale farming for income generation and for a significant share of their food (Cochrane and D'Souza, 2015). Agricultural production in Tanzania provides employment and source of livelihood to about 80% of its people and it contributes 27% of GDP and 35% of foreign currency (Muhihi *et al.,* 2012). It also dominated by smallholder farmers (peasants) cultivating average farm sizes of between 0.9 and 3.0 hectors each. In addition, cereals are the major food crops grown and consumed by majority of households in the country. About 33% of the total area under cultivation is used for cereal crops production; and it account for 34.8% of the total food crops production in the country (FAOSTAT, 2015; Muhihi *et al.,* 2012).

Maize is the major cereal crop grown and consumed in almost every region in Tanzania (Cochrane and D'Souza, 2015). It was introduced in the 17th century and spread to the inner parts by mid-19th century by Portuguese and Arab explorers (Suleiman and Rosentrater, 2015). It soon became an important cereal crop all over the country and accepted by many ethnic groups. More than half of cultivated land in Tanzania is allocated to cereal crops but, maize is the major and most preferred staple crop among all staple and cash crops being produced (Suleiman and Rosentrater, 2015). It is grown by more than 60% of the crop-growing households, on over 40% of the cultivated land (ESRF and ECDPM, 2015). The popularity of maize is evidenced by the fact that it is grown in almost all agro-ecological zones in the country. Over two million hectares of maize are planted per year with average yields of between 1.2–1.6 tonnes per hectare. About 4.2 million hectares (31% of all arable land and 65% of total area planted with cereals) is planted with maize; accounting for 63% (6.7 million tonnes) of the total food crops produced (FAOSTAT, 2015; Suleiman and Rosentrater, 2015; Muhihi *et al.,* 2012). As shown in Figure 1, maize production in Tanzania has doubled from 3.1 million tonnes in 2005 to 6.74 million tonnes in 2014 with the annual growth rate of 4.6% over last 25 years (FAOSTAT, 2015; Suleiman and Rosentrater, 2015).

In addition, maize has been identified as a significant crop to enhance poverty alleviation, income, food production and food security (Suleiman and Rosentrater, 2015). This is substantiated by the fact that maize is the main staple crop of high significance to the Government of Tanzania (GoT), especially in implementing the Big Result Now (BRN) program in the agricultural sector (Mtaki, 2016). The BRN program has a goal of increasing maize production by 100,000 ha/year starting from 20015/16 season, to reach 330,000 ha in smallholder production and 350,000 ha in commercial production by 2025 (Mtaki, 2016).

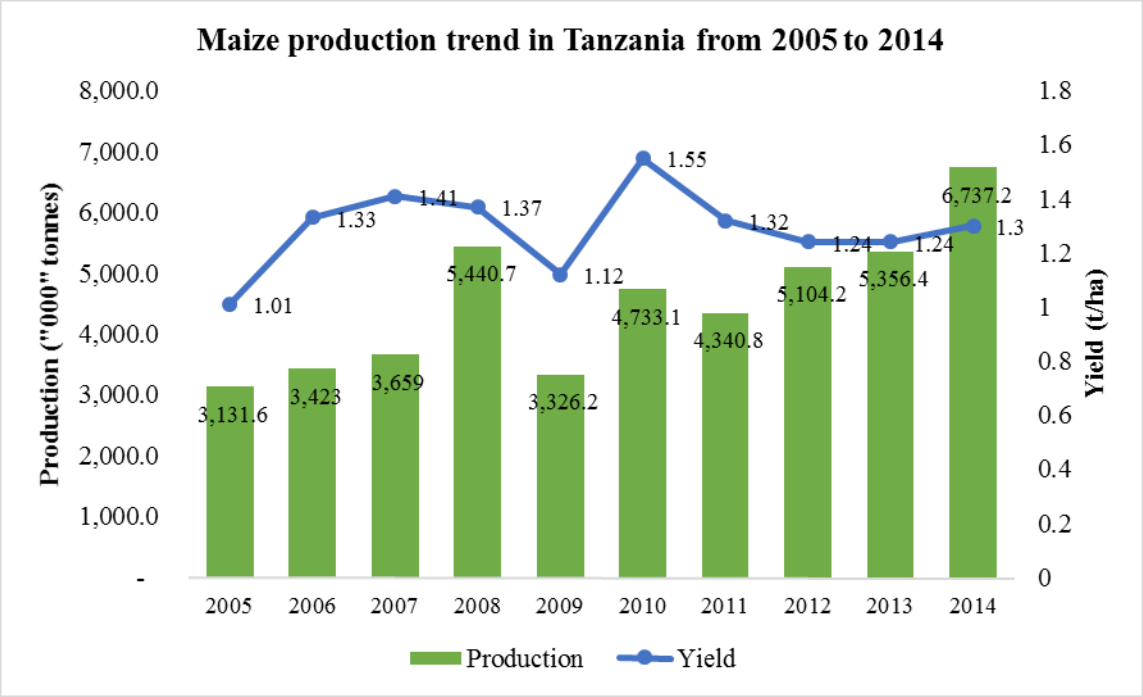

Figure 1: Maize production trend in Tanzania from 2005 to 2014
(Source: FAOSTAT, 2015)

Tanzania produces maize in two rainfall seasons (*Masika and Vuli*). About 41% is grown during Masika season and around 47% grown on Vuli season (Suleiman and Rosentrater, 2015). The National Maize Research Program (NMRP) and the Ministry of Agriculture Livestock and Fisheries (MALF), the then Ministry of Agriculture, Food Security and Cooperatives (MAFC) divided maize production area into three main agro-ecological zones. These are; (a) the Southern zones which include Iringa, Rukwa,

Ruvuma, Njombe, and Mbeya, these regions are the largest producers of maize (is so-called the *breadbaske*t) and account for over 45% of the total annual maize production; (b) the Lake zone includes Mwanza, Simiyu, Mara, Geita, and Kagera, collectively these regions produce around 25-30 percent of the total maize output; and (c) the Northern zone consists of three regions, Arusha, Kilimanjaro, and Manyara, it accounts for about 10% of the total maize production (Suleiman and Rosentrater, 2015).

There are four categories of groups that produce maize in Tanzania. The first group comprise smallholder farms sized 2-3 ha each; the second group community farms with around 50 – 100 ha; the third group includes large scale farms with over 100 ha; and the final group include large private and public farms (<100 ha) (Suleiman and Rosentrater, 2015). Smallholder farms (subsistence farming) is the most essential group as it produce about 85% of the total maize production, leaving some 10% and 5% to the production in medium- and large-scale farms respectively (Mtaki, 2016; ESRF and ECDPM 2015).

The traditional staple diet in Tanzania is based on cereals (maize, rice, sorghum and millet), starchy roots (cassava and sweet potatoes), and pulses (mainly beans) (Muhihi *et al.,* 2012). Cereals provide 40% to 60% of the total dietary energy supply (DES) (Oniang'o *et al.,* 2003). Per capita supply of cereals in the country is 291 grams/capita/day in which the supply of maize is 160.19 grams/capita/day; this makes the country one of the highest consumers of maize in African region (FAOSTAT, 2015). The supply of rice and wheat are 86 grams/capita/day and 44 grams/capita/day respectively (FAOSTAT, 2015). Despite that the country is the maize basket for the region, and that it is consumed by majority of households ("Agricultural sector output," 2016); currently on the 2015 Global Hunger Index (GHI), Tanzania is ranked 77th out of 104 (countries with GHI scores greater than five) with a score of 28.7 basing on the proportion of people who are calorie deficient; child malnutrition prevalence; and child mortality. Also, the 2016 Global Food Security Index (GFSI) indicates that, Tanzania is ranked 94th out of 113 countries, with a score of 36.9 (out of 100) basing on food affordability, food availability and food quality and safety (The Economist Intelligence

Unit, 2016; IFPRI, 2015). This situation is alarming to the country's food policy makers and the nation at large (Gret, 2014).

Manyara region is one of the main producers of maize in Tanzania. Maize is the dominant crop being produced in the region as it has the highest area (1.36 ha) planted with maize per household and the number of households growing maize during the long rainy season is 91.7% of the total annual crop growing households (URT, 2013). Babati is the second district in the region with the largest area planted with maize (57,685 ha) and it is the first district with the largest number of agricultural households (43,123hh, 32.5%). On average, Babati district contributes about 27.6% (about 68,428.44 tonnes/year) of the total maize production in the region per annum; Kiteto, Hanang, Mbulu and Simanjiro contributes about 23.3%, 19.8%, 18.2% and 11.1% respectively (URT, 2016; URT, 2013).

Therefore, due to the fact that food insecurity can lead to some physical harm to the individual and malnutrition; it will have a direct impact on economic performance in terms of productivity. Also, given the importance of maize as a staple crop to almost all households in Tanzania; there is a need to study maize production towards household food security in Tanzania using Babati District as a case study.

1.3 Problem Statement

Although maize is cultivated in many parts of Tanzania and the role that it plays as a food crop, for the past five production seasons (2010/11 to 2014/15) the average maize yield per hectare was 1,403.08 kg/ha (1.4 t/ha) (FAOSTAT, 2015). This indicates a low maize yield compared to the estimated potential yields of 4 – 5 tonnes per hectare (Otunge *et al.,* 2010; Suleiman and Rosentrater, 2015). Given that maize provides 60% of dietary calories and that the main staple food to the people in Tanzania is *ugali* (a stiff porridge made from maize flour), the national's caloric requirements are yet to be met on sustainable basis as the average maize consumption from production seasons of 2010/11 to 2014/15 is only 406 kcal/cap/day; compared to the estimated basic

requirements to meet food needs that range from 1,885 to 2,500 kcal/cap/day (IFPR, 1999; Muhihi *et al.,* 2012; Baha *et al.,* 2013; FAOSTAT, 2015).

Babati District is developing as a result of increasing commercial activities which has contributed greatly to the rise in the number of people in the district. Large amount of food consumed by majority of households is produced within the district. Hence, any change that might occur on farm yields will have a direct impact on household's caloric intake. The district has fifty-one percent of households that experience food insufficiency (URT, 2012). Babati district has a potential of producing about 3 tonnes/ha. However, over the past five seasons, the average maize yield was 1.8 tonnes/ha with an annual growth rate of 0.94% (Babati District Council, 2015). This indicates a low maize yield and production despite the efforts by farmers to increase area under maize production with a view of increasing output per hectare. Low maize yield in Babati is a problem which threatens not only the economic well-being of farmers but also the efforts by the government to ensure food security (Baha *et al.,* 2013).

Moreover, population growth as well as urbanization in Babati will increase the demand for food especially maize; bearing in mind that maize is the most consumed foodstuff not only in Babati but also in the country. Therefore, households may also wish to sell some proportion of maize produced to raise income that can enable them to have access to other varieties of food. Thus, this study aimed at understanding the contribution of smallholder maize production on household's food security in Babati District. Specifically, the study focused on examining maize production by households per year; identifying household caloric acquisition from maize; and challenges facing maize producers.

1.4 Objectives

The general objective of this study was to assess the contribution of maize production towards household food security in Babati District.

Specific objectives

i. To examine household's maize production per year in Babati District

ii. To examine household caloric acquisition from maize consumption in Babati District
iii. To investigate the challenges facing maize producers in the study area

1.5 Research Questions

i. What is the quantity of maize produced by a household per year in Babati?
ii. What is the quantity of calories acquired by households from maize consumption in Babati?
iii. What are the challenges facing maize producers in Babati?

1.6 Significance of the Study

This study explored the contribution of smallholder maize production towards household food security in Babati District. Due to the fact that majority of households in Tanzania depends on subsistence farming for their livelihoods; findings of this study are useful in policy formulation as far as improving food security in the country is concerned. Also, the results of this study will provide a basis for researchers interested in studying agriculture particularly maize production and food security in Babati district, so as to develop strategies on improving maize production and food security in the study area.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter highlights a literature review on food security. It begins by a theoretical literature review explaining Sen's theory of hunger and measurable indicators of food security. Then, the chapter highlights the empirical literature review on maize production; (globally, in Africa and in sub-Saharan Africa and in Tanzania); household's caloric acquisition; and income accrued from farming activities by smallholder farmers. This is followed by costs involved in maize production, revenue estimation from maize production, household maize consumption, contribution of maize to food security and challenges facing maize producers. The chapter ends with a conceptual framework illustrating sufficient maize production as one among the important variables for food security at household level.

2.2 Theoretical Literature Review

2.2.1 Sen's theory of hunger

This study was guided by Sen's theory of hunger. This theory attempts to explain the causes of famine at a household unit of analysis. According to Sen, famine occurs when a large number of people in a region lose their means (or entitlements) to access commodities (Devereux, 2001). Entitlements have been defined by Sen as the set of alternative commodity bundles that a person can command in a society using the totality of rights and opportunities that he or she faces. A person's entitlement set, is the full range of goods and services that he or she can acquire by converting his or her endowments (assets and resources, including labour power) (Devereux, 2001).

The entitlement approach aims comprehensively to describe all legal sources of food, which Sen reduces into four categories: production-based entitlement (growing food);

trade-based entitlement (buying food); own-labour entitlement (working for food); and inheritance and transfer entitlement (being given food by others) (Devereux, 2001).

Furthermore, Sen (1987) argues that, when millions of people suddenly die in a famine, it is hard to avoid the thought that there must have been a major decline in the output and availability of food in the economy. But while that is sometimes the case, there have frequently been famines in which food output and availability have remained high and undiminished. Therefore, the major concern is not primarily the overall availability of food, but the acquirement of food by individuals and families. However, when a person is lacking the means to acquire food, then the presence of food in the market is not much a comfort. So, in order to understand hunger, people's entitlements, meaning that, what commodity bundles, including food they can make their own, should be asserted.

The entitlement of a person stands for the set of different alternative commodity bundles that the person can acquire through the use of the various legal channels of acquirement open to someone in his position (Sen, 1987). A person has to starve if his entitlement set does not include any commodity bundle with adequate amounts of food. Also, a person is reduced to starvation if some change either in his endowment (e.g., alienation of land, or loss of labour power due to ill health), or in his exchange entitlement mapping (e.g., fall in wages, rise in food prices, loss of employment, drop in the price of the good he produces and sells), makes it no longer possible for him/her to acquire any commodity bundle with enough food (Sen, 1987).

Therefore, since the majority of the poor are dependent on agriculture for their livelihood (FAO, 2011). Achieving nutrition and food security is a prerequisite to the achievement of all the Millennium Development Goals (MDGs). Therefore, investing in food and nutrition makes political, economic and social sense (UN, 2012). Thus, food security at both macro and micro levels enhances the prospects for rapid economic growth, poverty reduction and broad-based participation by citizens in higher living standards (Timmer, 2004). Concern for the short-run food intake of the poor, and their

nutritional well-being, is also important (Timmer, 2004). Since economic growth only will not resolve problems like chronic malnutrition and stunting (Torero, 2014).

Li and Yu (2010) argued that, farm production and purchase from market are the two major channels for rural household to achieve food security. Although, today's rural areas have changed and offer different business opportunities, not only in agriculture, but also in service sectors, most of the production is conducted by farming households with the belief that production plays an important role in rural livelihood strategies. Therefore, the primary solution to solve the immediate problem of hunger is through smallholder production of food and the generation of sufficient income to enable rural populations to buy enough food (Matshe, 2009). For that case, this study employed the Sen's theory of hunger in the analysis of food security since farmers in Babati depend on agriculture as a major source of food (Baha *et al.,* 2013).

2.2.2 Measurable indicators of food security

Given the multidimensional nature of food security, practitioners and policy makers have long recognized the need for a variety of means of measurement (Maxwell *et al.,* 2013). For many years, age-adjusted per-capita caloric intake was considered to be the best measure for access to food at the household level and measures of nutritional status were the best standard at the individual level (Maxwell *et al.,* 2013). However, there is no standard methodology for measuring food security that will capture all aspects of food insecurity (Kirkland *et al.,* 2013). The following are some of major food security indicators used in assessing different dimensions of food insecurity.

Global Hunger Index (GHI): This was designed by the International Food Policy Research Institute (IFPRI) to capture the multidimensionality of food insecurity. The index is constructed by equally weighing 3 indicators: the proportion of the population who are food energy deficient (based on DES); the percentage of children under five that is underweight; and the under-five mortality rate of children (Pieters *et al.,* 2012). A country's GHI score is calculated by averaging the percentage of the population that is undernourished, the percentage of children younger than five years of age who are

underweight, and the percentage of children who die before the age of five. This calculation results in a 100-point scale on which zero is the best score (no hunger) and 100 the worst, although neither of these extremes is reached in practice. A value of 100 would be reached only if the whole population was undernourished, all children younger than five were underweight, and all children died before their fifth birthday. A value of zero would mean that a country had no undernourished people in the population, no children younger than five who were underweight, and no children who died before their fifth birthday (IFPRI, 2014).

Global Food Security Index (GFSI): This was compiled by the Economist Intelligence Unit of the British based on three major dimensions of food security. These are; food availability, food affordability and food quality across countries. The data is updated on a quarterly basis (Pieters *et al.,* 2012). The main objective of GFSI is to determine which countries are most and least vulnerable to food insecurity. The index is constructed from 28 unique indicators which measures the drivers of food security across 113 countries. Scoring criteria is based on three categories of scores calculated from the weighted mean of indicators scaled from 0 to 100; whereby, 100 = most favourable. The scoring categories are: affordability, availability and quality and safety. The total score for the GFSI (on a range of 0-100) is computed from a simple weighted average of the category scores (The Economist Intelligence Unit, 2016).

The FAO method: This is a country-level indicator of undernourishment. It estimates the per capita intake of calories at the national level using Food Balance Sheets and energy intake variance data resulting from household income and expenditure surveys (Pérez-Escamilla and Segall-Corrêa 2008). It reflects the proportion of the population with per capita dietary energy consumption below the standard minimum energy requirement (Pieters *et al.,* 2012). That is, the proportion of the population considered as undernourished. This proportion is estimated by comparing the hypothesized distribution of per capita energy consumption (in calories, mostly based on country-level aggregate data on dietary energy supply (DES) per capita – but occasionally this can be based on household-level survey data as well); with the minimum per capita requirement cut-off

point. The DES measure focuses on the food availability dimension of food security at the country level (Pieters *et al.,* 2012). Hence, in order to apply this method, countries need the following information; (a) total calories available in year of interest; (b) number of people living in a country in year of interest; (c) coefficient of variation of caloric intake to generate the energy intake distribution curve; and (d) cut-off point to estimate the proportion of the population falling under the minimum per capita average caloric requirement (Pérez-Escamilla and Segall-Corrêa, 2008).

Household-level of energy intake: The daily food energy availability per capita is calculated by converting household food expenditures into calories and averaging out the household-level figure over the number of adult equivalent household members (Pieters *et al.* 2012). However, nutrient intake varies among the individuals and households, largely depending on food tests, food preferences, religion, food availability and people's purchasing power in that particular community. The other factors influencing adequate nutrient intake by individuals in a household include environmental, socioeconomic and political factors (Abdalla, 2014).

Household diet diversity: This is the number of different varieties of food or food groups consumed over a reference time period without concerning the frequency of consumption (FAO 2008). Traditionally, it has been measured using simple count of food or food groups consumed in a reference period, normally between 1 and 15 days (Kirkland *et al.,* 2013). This type of measure captures the number of different kinds of food or food groups that people eat and the frequency with which they eat them. The result is a score that represents the diversity of intake, but not necessarily the quantity, though such scores have been shown to be significantly correlated with caloric adequacy measures (Maxwell *et al.,* 2013). There are two indicators of food insecurity which measure the diet diversity, in particular: (i) Diet diversity, constructed by classifying food into seven categories (cereals, roots and tubers; pulses and legumes; dairy products; meats, fish, seafood and eggs; oils and fats; fruits; vegetables) and by summing up the number of different food categories that is consumed by the household during the reference period. (ii) The share of calories from staple foods out of total calorie intake at

the household level. Poor households will have a high marginal utility of calories, and hence choose a diet which achieves as much as possible calories within its budget constraint. Staple foods are usually the cheapest source of calories; hence poor households will have a higher share of calories provided by staple foods. As households expand their budgets, they will increasingly substitute towards foods which are relatively more expensive in providing calories, but have higher level of other preferred attributes, such as taste (Pieters *et al.,* 2012).

Individual-level energy and nutrient intake: Comprised of the information on the nutritional intake at individual level (Pieters *et al.,* 2012). It provides detailed information concerning the distribution of food within the household. This information is collected either as food records of daily intakes or as one-day dietary recalls; and they normally cover a short period of time (Murphy *et al.,* 2012). The advantage of collecting information on individual intake of nutrients or energy is that, it is possible to control intra-household access to food; and the different food consumption patterns of special groups like pregnant women and elders (Pieters *et al.,* 2012). The disadvantage of individual-level energy and nutrient intake survey is that, it is expensive and typically time consuming to conduct for a large population like nationally representative sample (Murphy *et al.*, 2012).

Anthropometric indicators: It is defined as the measurement of weight, size, body proportions and eventually the composition of the human body (Pérez-Escamilla and Segall-Corrêa, 2008). It focusses on the consequences of malnutrition (Pieters *et al.,* 2012). It measures the impact of both health status and food security of the individuals. The anthropometric indicators that are usually used in the national surveys are based on height (length) and weight of infants, young children, youth and adults. Interpretation of adequacy of anthropometric indicators is based on the established cut-off points (Pérez-Escamilla and Segall-Corrêa, 2008). For example, anthropometric indicators for children below the age of five focus on physical growth and low weight. Firstly, low weight-for-weight (substantial weight loss resulting from health problems or acute food shortage); secondly, stunting (low height-for-age and is an indicator for chronic malnutrition); and

thirdly, underweight (low weight-for-age and results from the combination of short-term weight loss and long-term growth problems) (Pieters *et al.,* 2012). These indicators are calculated by comparing height and weight of a child with reference to a population of well-nourished and healthy children. For adults and elderly, the anthropometric indicator is body mass index. If an adult/elderly has a body mass index lower than 18.5 he/she is considered to be malnourished. Again, if an adult/elderly has a body mass index higher than 25 indicates a risk of overweight. The body mass index is associated with the risk of mortality and morbidity for elderly (Pieters *et al.,* 2012). This study employed the household level of energy intake and household dietary diversity indicators since the study was done at household level to identify the quantity and quality of food consumed by household members.

2.3 Empirical Literature Review

2.3.1 Maize production

2.3.1.1 Global maize production

The word maize is used interchangeably with corn in the Western world. This is because, under early British-American trade, the term corn was used for all grains; and the term was recalled maize since it was the most common grain in trade. Even though the origin of the term maize is also debatable (Ranum *et al.,* 2014); it is largely believed that the word originated in Arawak tribes of the native people of the Caribbean. Linnaeus included the name as species epithet in the botanical classification Zea (*Zea mays L.*), on the basis of this common name (Ranum *et al.,* 2014).

It is believed that, maize was one of the earliest crops to be cultivated by farmers in the past 7,000 to 10,000 years. This is due to a proof of maize as a food coming from some archaeological sites in Mexico where some small corn cobs, estimated at more than 5000 years old, were found in caves. Also, the discovery of fossil pollen and cave corncobs in archaeological sites prove that maize originated in Mexico. There are other thoughts which stated that maize was founded in the area of the Himalayas in Asia, as the product of a cross between Coix spp. and some Andropogoneas (probably of the Sorghum

species), mutually parental chromosomes with five sets, or in the great Andes of Bolivia, Ecuador, and Peru, as demonstrated by the existence of popcorn in South America and the extensive genetic variety existing in the Andean maize, particularly in the highlands of Peru. Indigenous of America changed maize over period of 1000 years to a crop with larger cobs and more rows of kernels to make it a better source of food, by thoroughly gathering and cultivating plants which were more suitable for human consumption (Ranum *et al.,* 2014). Hence, it provided sufficient food to the greater part of their diet for the whole year, allowing societies to live in one place for a prolonged period of time (Ranum *et al.,* 2014).

Maize spread remarkably and rapidly from its area of origin (Mexico) to other areas of the world due its development as a cultivated crop and as a diversity of food products. The residents of several ethnic tribes in Mexico and Central America took the plant to other areas of the Caribbean, Latin America and then to Canada and the United States. European pioneers brought maize to Europe and then later merchants transported maize to Asia and Africa (Ranum *et al.,* 2014).

There are different kinds of maize which are grown all over the world, only being differentiated with colour. The colours for maize grains can be distinguished ranging from white to yellow to red to black. The yellow maize is mostly grown in United States of America; whereas, white maize is mostly preferred in Africa, the Southern United States and Central America (Ranum *et al.,* 2014). In Africa, yellow maize is not common or preferred due to the perception of social status by many people; seemingly, it is connected with food-aid programs and is assumed to be consumed only by poor people (Ranum *et al.,* 2014).

Yellow maize is commonly used in the feed industry to manufacture animal feed. The main reason behind preference for white maize in Africa is mainly due to traditions, in these countries (in Africa) people tended to consume white maize. The quality of white maize is important because it affects grading, yield of high quality products and milling performance (Ranum *et al.,* 2014).

Maize together with wheat and rice are the three most cultivated cereal crops in the world (Ranum *et al.,* 2014). The top five maize producing countries in the world are United States of America (USA), China, Brazil, Mexico and Indonesia (Cairns *et al.*, 2013). It was projected that in 2012, the aggregate world production of maize was 875,226,630 tons, whereby, the harvests in the USA, China, and Brazil was 31, 24, and 8 percent respectively of the global maize production (Ranum *et al.*, 2014).

The current world maize production is about 10.14 billion metric tons whereby; USA is the leading maize producer contributing to 35.35 percent of global maize production followed by China (21.11%) (Table 1). The other major producers of maize in the world are; Brazil (7.82%), Argentina (3.23%), Ukraine (2.79%), India (2.32%) and Mexico (2.28%). Africa produces around 8.2 percent of the total world production. Two-thirds of all Africa maize comes from Eastern and Southern Africa (ESA) (FAOSTAT, 2015; Suleiman and Rosentrater, 2015).

Table 1: Top maize producing countries in the world in 2014

Country	Production (t)	Percentage (%) in World Production
United States of America	361,091,140	35.35
China	215,646,300	21.11
Brazil	79,877,714	7.82
Argentina	33,000,000	3.23
Ukraine	28,496,810	2.79
India	23,670,000	2.32
Mexico	23,273,257	2.28

Source: FAOSTAT, 2015

2.3.1.2 Maize production and consumption in Africa

Cereals are the fruits of cultivated plants. They offer humankind with supplementary nourishment than any other food class and approximately half of the entire caloric requisite (Ranum *et al.,* 2014). Despite that there are many types of cereal crops consumed for food; maize, rice and wheat are only important human food sources, as they account 94% of the total cereal consumption. The intake or preference of these

cereals differs widely from region to region; in Europe, Central Asia, the Middle East and South and North America, wheat is the favourite cereal. In Asia, rice is the main cereal crop; and in Southern and Eastern Africa, Central America, and Mexico, maize (corn) is preferred (Ranum *et al.,* 2014).

Maize was introduced in the African continent in the 16th century, and by the 19th century, it had spread all over the continent (Olaniyan, 2015). It was initially received in the Coastal area (Pemba Island). The island was used by Portuguese planters on 16th century to cultivate food crops, including maize, to supply their coastal battalion. This was caused by world-wide ecological and demographic transformation by the Portuguese and Arab pioneers so as to provide the slave trade (Suleiman and Rosentrater, 2015).

Presently, maize is possibly, the most essential cereal crop of significant economic-wise in African countries that has replaced sorghum and millet (Olaniyan, 2015). It is a main food crop grown in diverse environments and consumed by people with different food preferences and socio-economic background in Africa. Its taste has been easily accepted by the native population and thus, it has been quickly replacing traditional starchy foods like cassava (Olaniyan, 2015). The other causes for the quick acceptance and spread of maize are that, it provides nutrients in compacted form and it can easily be transported; it gives one of the highest yields per man-hour of labour spent on it; it can be easily harvested and does not shatter; it stores well if properly dried; it can be harvested over a long period first as immature cobs; the husks give protection against birds and rain; but it can also be left standing in the farm to maturity before harvesting. Similarly, in terms of taste, majority of people have a preference for maize to their traditional cereals (Olaniyan, 2015).

The consumption of maize in Africa since 1980 has accounted for 22% to 25% of the overall starchy staple intake, demonstrating the major single source of calories, followed closely by cassava (Smale *et al.,* 2011). The importance of maize as a staple differs all over the continent. The highest quantities of maize consumed can be found in Southern

Africa at 85 kg/capita/year as compared to 27 kg/capita/year in East Africa and 25 kg/capita/year in West and Central Africa. In Malawi, Zambia, Lesotho, Zimbabwe and South Africa the normal intake of maize is over 100 kg/capita/year. These quantities represent more than 50% of total calories in Lesotho, Malawi and Zambia, 43% in Zimbabwe, and 31% in South Africa (Smale *et al.*, 2011).

As indicated in Table 2, currently in Africa, maize is grown in an area which covers 36.72 hectors, largely in smallholder systems that produced 77.4 million tonnes in 2014 (FAOSTAT, 2015). South Africa was the leading maize producer in the year 2014 with an annual production of 14.98 million tonnes which is equivalent to 19.36% of the total maize produced in whole of African continent. The second major producer in the same year was Nigeria with an annual production of 10.79 million tonnes (13.95 % of the total maize production in Africa in 2014). Despite having a small area harvested with maize (750,000 ha), Egypt had a high maize yield (7.73 t/ha) compared to other countries. This is followed by South Africa with 4.54 tonnes per hectare. Tanzania was the second country after Nigeria in terms of area harvested with maize (4.2 million ha) but its yield per hector was low (1.6 t/ha) (FAOSTAT, 2015).

Table 2: Major producers of maize in Africa in the year 2014

Country	Production (t)	Area harvested (ha)	Yield (t/ha)
South Africa	14,982,000	3,300,000	4.54
Nigeria	10,790,600	5,849,800	1.84
Ethiopia	7,234,955	2,114,876	3.42
United Republic of Tanzania	6,737,197	4,200,000	1.60
Egypt	5,800,000	750,000	7.73
Malawi	3,929,000	1,700,000	2.31
Kenya	3,513,171	2,116,141	1.66
Zambia	3,350,671	1,205,202	2.78
Uganda	2,763,000	1,105,000	2.50
Ghana	1,762,000	1,019,000	1.73

Source: FAOSTAT, 2015

2.3.1.3 Maize production in Sub-Saharan Africa

Maize is the most significant cereal crop and staple food for about 1.2 billion people in Sub-Saharan Africa (SSA) and it is the third crop which occupies the largest cultivated area (Suleiman and Rosentrater, 2015). It contributes 60% of dietary energy and 50% of protein intake accounting for over 30 % low income households (Suleiman and Rosentrater, 2015). In large parts SSA maize occupies a total of approximately 70 million hectors harvested with maize with an annual production of 34 tonnes in the year 2014. It accounts for 30% of the total area under cereal production in this region. In SSA maize is principally cultivated in small-holder farming systems under rain fed conditions with limited inputs. Low yields in this region are largely associated with drought condition, weeds, pests, low soil fertility, low input use, low input availability, and inappropriate seeds (Cairns *et al.,* 2013; FAOSTAT 2015). This makes SSA the most vulnerable region since high population growth rate demands for an increase in maize productivity (Otunge *et al.,* 2010). This is evidenced in Tanzania whereby due to rapid population increase, the estimated average number of malnourished people increased from 16 to 17 million people in 2013-2015 and 2014-2016 respectively due to inadequate consumption of calories and energy-proteins (FAOSTAT, 2015).

Tanzania is one of the main maize producers in SSA. In the past five decades, Tanzania was ranked among the top 25 maize producing countries in the world. Presently the country is ranked among the top maize producing countries in the world since it is the first in East Africa (EA), fourth in Africa and nineteenth in the World (FAOSTAT, 2015).

2.3.1.4 Costs of maize production in Sub-Saharan Africa

The production of maize or any other crop, involves production costs that are usually incurred by farmers. These costs involve all the resources used in farming activities throughout a particular season. They can be divided into fixed costs and variable costs. Fixed cost is the amount of total cost which is considered as fixed in the short period so it cannot be controlled or avoided in the short period, regardless of the intensity or level

of production (Khairo, 2009). These are costs which do not vary with usage. For example, the costs associated with owning farming machines or equipment; the fixed costs may include depreciation, insurance, interest cost, registration cost, shedding cost and/or workshop cost. So a farmer pays these costs each season irrespective of whether he has used the machine for 1 hour or 100 hours (Khairo, 2009). Other kinds of fixed cost include rent on cultivated land and marketing agent's fee (Oladejo and Adetunji 2012). One more type of cost incurred by farmers is variable costs. Variable cost is the proportion of total cost which vary (approximately) with changes in the scale of an enterprise within a given production system or when the amount of production per unit changes (Khairo, 2009). They are the costs which can be avoided or controlled in the short period. So, variable costs include; land preparation cost, seeds cost, weeding cost, agrochemicals cost, fertilizer cost, harvesting cost, assemblage cost, transportation cost and storage cost (Oladejo and Adetunji, 2012). Fixed costs are incurred mostly in commercial or large scale agriculture which includes the adjustments of the natural environment and the usage of mechanised machinery; hence, this study focused on variable costs because it assessed maize production at household level which is normally characterised by subsistence farming (Masvongo, *et al.*, 2013).

Despite that the use of oxen in developed countries has lost its importance, still draft animals in many countries in Africa are the major source of power for farming activities and transport. In SSA, the use of oxen has continued to raise in numbers and importance whereby, 65% of farm activities is done manually by hand, 25% by animal power and just 10% with tractors. Usually, the use of oxen is of high importance for farming activities especially in areas with low adoption of modern forms of farming mechanisation. The use of tractors to the majority of households in Africa is low because tractors tend to be more suitable for large-scale farming than subsistence farming; also the ownership of tractors by individuals is rarely possible for subsistence farmers due to initial high expense. Despite the benefits of using tractors, animal power is more readily accessible and at an affordable cost to the majority of households in Africa. The use of oxen for farming activities in Sierra Leone has shown to be very important to farmers.

This has been influenced by the augmented demand for the production of food. A pair of oxen can be used to plough 0.17 to 0.20 hectors in a five-hour working day and using a triangular spike-tooth harrow, one hectare can be ploughed in five hours. The cost of using hand hoe, oxen and tractor for farm ploughing in Sierra Leone is 112,500 Leones/ha (USD 188), 60,200 Leones/ha (USD 100) and 94,320 Leones/ha (USD 157) (Teweldmehidin and Conroy 2010; Kanu, 2000).

Weeds remain as a major constraint in the production of maize by the subsistence farmers. So, it is one of the farm activities to which farmers incur costs (Omovbude and Udensi 2012). The difficulty to control weeds by subsistence farmers is caused by patterns or onset of rainfall, cultural practices, poor quality weeding, expensive multiple weeding, seedbed preparation, intercropping and labour availability. Smallholders conduct few ploughing operations (mostly one breaking) where weeds are narrow covered, thus germinate easily. Also, smallholder farmers tend to preserve some other plants which they consume as vegetables which later affect weeding. Sometimes they delay to weeding purposefully so as to allow these plants (vegetables) to grow, consequently allow the germination of the real weeds (Muzari, *et al.,* 2012).

Weeds cause crop losses because it increases plant competition for nutrients, light, carbon dioxide and water. Also it makes household members to devote a significant proportion of their time on weeding. This is because; more than fifty percent (50%) of labour time is spent on weeding. Hence, weeding increase the costs involved in maize production (Tesfay *et al.,* 2014). The control of weeds is widely implemented by smallholder households in SSA. Majority of smallholder households use hand hoes to conduct weeding. The use of herbicides to control weeds by smallholder households is very minimal because the limited resources that they have to purchase sprayers and herbicides; also the low skills and insufficiency water supply constraints them. Mulching is another weed control method but it is not popular to majority of farmers probably due to lack of awareness by farmers (Muzari, *et al.,* 2012; Omovbude and Udensi 2012). Generally, the uses of these methods are based on their economic efficiency and awareness to farmers. That is why the use of hand hoe is a predominant method in weed

control among smallholder households in Africa. Despite its widely usage, this method is laborious, expensive and time consuming. For instance, by using hand hoe, one hectare of a maize farm may need 25 people per 40 days, depending on the cropping system adopted and the density of weeds. This implies the use of approximately 50% - 80% of the total labour budget (Omovbude and Udensi, 2012). In North-Eastern Uganda, hand hoe weeding accounted to 51.3% (USD 27.85) of the total costs (Sims and Kienzle, 2016). Again in Ekpoma Nigeria, the use of hand hoe accounted to 58% (USD 140.4) of the total cost incurred in weeding; other weeding methods accounted 42% (USD 101.6) of the total weeding cost. The profit generated by farmers from the use of hand hoe and other methods in weeding was USD 29.82 (10%) and USD 267.44 (90%) respectively (Omovbude and Udensi, 2012).

The use of improved hybrid seeds in maize production is one of the food production practices that need to be improved. So as to reduce food insecurity among households in sub-Saharan Africa, agricultural productivity should be increased by promoting the production of cop varieties with high yields. The selection of hybrid seeds by farmers is based on insect resistance, disease resistance, high yields, drought and stress tolerance and high response to improved cultural practices (Muzari, *et al.*, 2012).

The major constraint for smallholder farmers is that, hybrid/improved seeds cannot be successfully recycled because they tend to lose hybrid vigour when the seeds harvested in one season are replanted in the next season. Also, the germplasm of hybrid seeds become obsolete (out of date) rapidly because it might only be marketable for 2 – 3 years; whereas, the average time a seed is on the market is approximately 5 years. This makes the use of hybrid seeds to be of higher cost than that of using traditional maize seeds. However, despite these limitations, the use of hybrid seeds in sub-Saharan Africa has become a common tradition to smallholder farmers. Farmers purchase hybrid seeds from agro-dealers. Agro-dealers choose the types and quantity of hybrid seeds to sell depending on the demand and preferences of farmers (usually basing on maturity period and yield). The costs of hybrid seeds from the town centre to remote areas vary due to transportation expenses (Waldman *et al.*, 2016). The cost of maize hybrid seeds incurred

by farmers in Bangladesh accounted 16% of the total production cost of 63,558 Bangladesh Taka (USD 826.254) per hectare; with the average yield of 3110 kg/ha (Haque *et al.*, 2012).

So as to exploit the full potential of maize hybrid yields, the use of fertilizer at an optimal level is necessary (Schroeder *et al.*, 2013). For the most part of sub-Saharan Africa, the optimal use of fertilizer results to hybrid seeds to be more productive (Muzari, *et al.*, 2012). However, despite the increased availability of fertilizer, the high cost resulting from transportation expenses limits the adoption and use of rational amount of fertilizer in resource-poor smallholder households; hence, to a large extent, the cost of fertilizer may determine the quantity of fertilizer to be used (Schroeder *et al.*, 2013; Udoh and Umoh 2011). The use of fertilizer in Bangladesh accounted 26% of the total cost in maize production; out of it, 3% accounted the use of cow dung (organic fertilizer) and 23% from the use of inorganic fertilizer (Haque *et al.*, 2012). In Nigeria, farmers failed to use the optimal quantity of fertilizer in their farms due to high cost. Most of them (55.9%) were able to purchase fertilizer at 1,800 – 2,000 Nigerian Naira (USD 6.48 – 7.2) (Udoh and Umoh 2011).

2.3.1.5 Revenue estimation from maize production

In Africa, it is estimated that, about 60% to 70% of households depend on agriculture for employment; and on average, agricultural sector contributes to approximately 34% of GDP per country (Coster and Adeot, 2015). In Nigeria, agriculture contributed to an average of 40.78% of GDP from 2006 to 2013 (Coster and Adeot, 2015). Despite its economic importance, African agriculture has been disappointing over many decades. Sub-Saharan Africa is reported as the only region in which per capita agricultural value added has not seen a substantial growth, rather a decreasing trend on average over the last three decades since 1961 with considerable variation over time and across countries. This declining per capita food production has resulted in increasing rural poverty, rising food prices, widespread famines and increasing food imports. Some of the aspects hampering agricultural progress in Africa comprise of, high cost and inaccessibility of

inputs such as fertilizers and improved seeds, insufficient investment in agriculture, inadequate access to credit by smallholder farmers, insufficient use of contemporary technologies, inefficient agricultural input markets, and the absence of a favourable policy environment (Boniphace *et al.,* 2015).

For the majority of households in sub-Saharan Africa, maize is the principal cereal not only for food supply but also on its economic value. This is because it can be produced in various agro-ecological zones. The variation in agro-ecological zones influences maize yield and consequently income accrued. In Nigeria, the average revenue accrued by farmers per hectare from maize production in one season was different across the three agro-ecological zones. In Montane Savanna, rainforest and Guinea Savanna farmers accrued N158,554.60 (USD 570.8), N140,081.9 (USD 504.3) and N109,237.15 (USD 393.6) respectively (Coster and Adeot, 2015).

In addition, according to Mutami (2015), income accrued by smallholder farmers in Zimbabwe tend to be lower in areas where crop production is low due to huge transaction costs. Huge transaction costs are the result of increasingly difficulties to access inputs, as most programmes concerning with input delivery have rolled back or have collapsed because of the liquidity crisis in the country. Also, the high default rates on loans accessed in banks, which have led them to be snubbed by local financial institutions. Furthermore, according to Osugiri, *et al.* (2012), smallholder farms in South-Eastern Nigeria accrued a gross profit of N32,620 (US$217.47) and the net profit was N28, 360 (US$189.07) per hectare of farmland in one production season. An indication that the income accrued by smallholder farmers was small because farming in the study area was still producing on a small scale (low crop productivity).

Furthermore, only 0.7% of maize farmers in SSA use improved seed varieties together with fertilizers. Profitability analysis have revealed a negative or a very thin gross margins for traditional maize production due to the use of local seeds, which respond poorly to fertilizers (Boniphace *et al.,* 2015). For example, in Kenya, the total income accrued by farmers who adopted maize hybrid seeds was 43% (13,000 Kenya Shillings)

higher than that of non-adopters (Schroeder *et al.*, 2013). Generally, in sub-Saharan Africa, maize production is still done mainly on smallholder farms that depend on family labour. So, all these factors lead to maize productivity to be low by international standards and to her own relative potential (ESRF, 2015).

2.3.2 Household maize consumption and food security

2.3.2.1 Drivers of household food consumption

Household food consumption is affected by many factors which are; food availability, food accessibility and food choice. But these factors are also influenced by disposable income, demography, geography, urbanization, globalization, marketing, religion, culture and consumer attitudes among others (Kearney, 2010).

The basic economic theory state that, households purchase foods and other market goods to maximize utility, or well-being, based on their preferences and subject to the constraint that the cost of those goods is less than or equal to the sum of all sources of income. So it means that, apart from preferences, consumers (households) choose or consume varieties of food within the range of household's available resources (Caswell and Yaktine, 2013).

Furthermore, according to Regmi and Meade (2013), household expenditure on food items increases as the income levels increases. This means that, due to increased income, households may devote a proportion of that extra income on buying food, but then will also allocate some proportion that additional income on non-food items more than before. The increase in income, leads to the increase in food expenditure in lower income levels than in higher income levels. This is why due to the increase in incomes in lower income countries, their food expenses raise and the patterns of food intake seem to seek to reach to the ranks and composition of those of higher income countries.

The global per capita income is estimated to rise at a rate of more than 2% per year over the next three to four decades. Developing countries are expected to rise at even higher rates starting from a low base (Kearney, 2010). Food consumption in these countries is

approximately 2400 kcal/capita/day and mostly it comprises of cereals, roots and tubers; protein and fat containing food products such as meats, dairy products and vegetable oils are also becoming more significant. This is contrary to developed countries whereby, the supplementary income will not lead to further increases in caloric intake, but may reasonably lead to extra expenditure on food diversification, improved quality, convenience, or for food which satisfies consumer values such as organic, fair trade, and animal welfare. This is because, majority of these countries are moving closer to a food intake level close to satiety, where by the average daily per capita consumption is around 3500 kcal (FAOSTAT, 2015; Regmi and Meade, 2013).

Households in developed countries have relatively lesser food budget shares, which enable them to have sufficient income for other necessities, as well as recreational and cultural activities. For example, in the United States, food expenditure at home accounts for less than 10% of private consumption expenditure (PCE), quite different with Cameroon, where it accounts for 47% (Regmi and Meade 2013). Also, there are dissimilarities in dietary patterns between urban and rural areas in developing countries. In rural areas they allocate a higher proportion of their income to food as compared to urban areas and middle income households (Ofwona, 2013).

Generally, income changes cause budget responses which not only vary among consumers at different income levels, but also vary across different varieties of food products. For example, consumer's willingness to spend some amount of money at his disposal on fresh fruits and vegetables tend to increase when the levels of income increase because, fruits and vegetables are characteristically alleged as high-value products. The same applies to consumer's willingness to spend a proportion of income on staple food items like cereals compared with higher valued food items like meat and dairy products (Regmi and Meade, 2013).

2.3.2.2 Nutritional aspects of maize in Tanzania

Nutritional requirements change during the course of the lifecycle; needing changes in the types and amounts we consume so as to maintain the ideal health. The most critical

period of human growth is from conception to about three years of age, a period when most physical development happens. In this period, nutrition is important for the growth and development, bone and skeletal tissue formation, brain development and in adequate protection against early onset of chronic diseases such as hypertension, diabetes, heart diseases, osteoporosis, and some forms of cancer (Rana and Khan 1985). The requirement for protein from maize is much higher than requirements for reference egg or milk proteins. This is due to the fact that maize has much lower protein quality (Net Protein Utilization) when compared with reference proteins and thus higher amounts have to be consumed to meet protein needs; though a growing child may be unable to consume large amounts of cereals to meet his protein needs. The estimates of human requirements of proteins from maize can be seen in appendices (Rana and Khan, 1985).

The processing and consumption of maize differs from country to country, and maize flour and meal are the two most popular products. The real human intake of maize and other cereals is slightly lower than the expected figures due to use in non-food products, waste and because milling eliminates some of the outer layers, or bran, which is generally used as animal feed. Like with other cereals, the high amount of micronutrients is concentrated in the outer layers of the maize grain; therefore, removing these layers through the milling process leads to the loss of most vitamins and minerals. The consumption of maize can be better assessed by adjusting the values of cereal crops used for food and human food sources by bearing in mind the extraction rate (the proportion of flour produced from the whole-grain cereal). In many countries, the extraction rate range from 60% to 100% depending on the type of the maize (Ranum *et al.*, 2014).

In relation to nutrition, the meal frequency pattern and the distribution of food within the family are important factors to be considered (Oniang'o *et al.,* 2003). Tanzania is experiencing a nutrition change because of variations in dietary habits, particularly between middle- and high income groups living in urban areas that tend to consume high energy dense and processed foods. This nutrition transition is associated with an increase in diet-related chronic diseases such as obesity and type 2 diabetes mellitus.

Traditionally, staple foods in Tanzania are basing on cereals, starchy roots and pulses; though cereals and tubers are consumed in all regions in Tanzania (Muhihi *et al.,* 2012).

The main food crops in Tanzania in terms of quantity in production are cassava, maize, sweet potatoes, bananas, rice, irish potatoes, beans (dry), millet/sorghum, and wheat flour (Table 3). However, regarding to household food security, FAO lists commodities based on their caloric contribution to the diet of the average person. Basing on the level of calorie intake by crop in Tanzania, maize, rice and cassava were identified as the three most important crops for domestic consumption. Maize provides 38.1% of calories to the country as a whole, while 13.2% comes from cassava, 15.1% from rice and 15.1% comes from bananas. Other crops (sweet potatoes, irish potatoes and dry beans) contribute 18.6% of the calorie intake of Tanzanian households. Despite that food security obviously hinges on more than just the consumption of these commodities, such ranking does provide an indication of each crop's relative importance in the diet in Tanzania (ESRF and ECDPM, 2015; FAOSTAT, 2015).

Table 3: Important food crops in Tanzania basing on production and consumption

Crop	Average Production from 2005-2013 ('000,000' tons)	Average Consumption from 2005-2013 (kcal/capita/day)
Cassava	5.95(29.1)	203.63(13.2)
Maize	4.81(23.6)	589(38.1)
Bananas	3.19(15.6)	233.38(15.1)
Sweet potatoes	2.43(11.9)	111.5(7.2)
Rice (paddy)	1.92(9.4)	233.88(15.1)
Irish potatoes	1.19(5.8)	33.25(2.1)
Beans (dry)	0.93(4.6)	142.38(9.2)

Figures in brackets indicates percentage proportional

Source: FAOSTAT, 2015

Generally, maize is by far the most important subsistence crop as it constitutes the main energy source in the Tanzanian diet (ESRF and ECDPM, 2015). It constitutes more than 75% of the cereal consumption in Tanzania and it is projected that the annual per capita consumption of maize is almost 128 kilograms. Approximately 400 grams of maize are

consumed per day per person. Around 34% to 36% of the average daily calorie intake in Tanzania are contributed by maize and the average national consumption is estimated to be above 3 million metric tons per year (Suleiman and Rosentrater, 2015; Peter *et al.*, 2013).

About 60% of the total maize produced in 2013 was used for food (human consumption) with the average waste of around 20.6%. Feed represented 16.1% and 0.5% was used for food manufacturing. The consumption of maize varies in form; ground maize flour is used to prepare ugali (stiff porridge) or thin porridge by mixing with water. Fresh (Green) maize is boiled or roasted on its cob and served as a snack or as popcorn which is also a common snack (Suleiman and Rosentrater, 2015; FAOSTAT, 2015). The human consumption of maize in Tanzania is higher compared to neighbouring country Malawi as maize consumption in Malawi accounts for 45% of total food quantity, 60% of energy, and 48% of protein consumption; and the estimate of per capita maize consumption is 382 grams (Mazunda and Droppelmann, 2012).

2.3.2.3 Contribution of maize to food security in the World

Cereals are known to be the major source of food as far as achieving food security in a country is concerned (Onasanya, and Obayelu, 2016). Maize is one of the most important food crops consumed in the world. Rice and wheat are the other two major food crops which together with maize provide more than 30% of food energy (calories) to at least 4.5 billion people in developing countries. However, maize is the principal source of food for the majority (millions) of people in Africa and Latin America as it contributes more than 20% of food calories. Its role for human consumption is based on the proportion of calories it contributes among all staple cereal crops across regions. Also, the role of maize as a source of proteins from all other staples is the same as its contribution of calories (Shiferaw *et al.*, 2011).

In developed countries, maize is used as an important component in animal feed and also used widely in industrial products like in the production of bio fuels. Over the past decade, the demand for maize has changed from a food crop due to a remarkable

demand increase as a livestock feed. This has been influenced by the rapid economic growth in Asia, Latin America, China, India and the Middle East which caused the increased demand for poultry and livestock products. In USA, maize is highly used as a raw material for industries especially as a key component in the production of bio ethanol. Despite this change of demand for maize, there are countries in America and Asia to which maize still provide important energy requirements. In Mesoamerica and Andean region, maize contributes 61% and 29% respectively of calories from the staple cereals. Mexico, Guatemala and Paraguay have the high maize supply of 986 kcal/capita/day, 820 kcal/capita/day and 551 kcal/capita/day respectively; additionally, in Democratic People's Republic of Korea and Nepal maize supply is 369 kcal/capita/day and 342 kcal/capita/day respectively. However, the demand for maize among households in some countries depend on household income; for instance, in Southern Asia where 46% of maize is used as food only by the poor households who cannot afford to purchase other staple crops like wheat and rice (FAOSTAT, 2015; Shiferaw *et al.,* 2011).

In developing countries, the use of maize for food accounts for 25% of the total demand. It is estimated that the world population will be around 7.7 billion people by 2020 and the figure will increase to approximately 9.3 billion by 2050. So the demand for maize in developing countries will increase twice as much (Shiferaw *et al.,* 2011). Approximately, the consumption is anticipated to increase for about 1.3% per year until 2020 (Onasanya, and Obayelu, 2016).

In sub-Saharan Africa, maize accounts 73% and 64% in Eastern and Southern Africa (ESA) and Western and Central Africa (WCA) respectively of the total demand for food (Shiferaw *et al.,* 2011). The major countries with high consumption of maize in the region are Zambia, Zimbabwe, Kenya, Burkina Faso, United Republic of Tanzania and Mozambique with 999, 743, 663, 596, 523 and 438 kcal/capita/day respectively (FAOSTAT, 2015). In Tanzania, maize is consumed in all regions and it is the most (31%) produced crop and it is also the most consumed cereal crop accounting for more than 75%. The annual per capita consumption of maize is estimated to be around 128 kg

(Suleiman and Rosentrater 2015; Muhihi *et al.*, 2012). Generally, maize is an important food crop in overcoming hunger and improving household food security especially to the poor households in Africa, Latin America and Asia (Shiferaw *et al.*, 2011).

2.4 Challenges Facing Maize Producers in Africa

One of the main challenges facing maize producers in Africa is the drought condition in most countries; which involve inadequate supply of rainfall both in time and space (Dao *et al.*, 2015). Majority of maize producing households in Africa depend on rainfall for their farming practices, hence it is the main factor which affect their produce and consequently food security. In semiarid areas the yield consideration is primarily reliant on the amount of rainfall for a specific duration and the distribution of rainfall (Munodawafa 2012; Omoyo *et al*., 2015). In lower altitudes of Africa, there is a possibility that maize yield will fall to about 20% to 50% due to dry and warm condition as a result of climatic change. For example, the augmented heat condition in many areas of lower-eastern Kenya has resulted to a lower maize yield. Yield inconsistency of maize poses a high vulnerability to food security among the majority of poor households in Kenya because maize is the most important food crop (Omoyo *et al.,* 2015).

Poor weed management is another constraint facing maize producers particularly in sub-Saharan Africa because it limits maize productivity. It decreases the efficient use of water and N (Nitrogen) which are the two most important inputs so as to achieve high maize yields. There are cultural methods which may be effective in weed control by destroying majority of weeds before they seed and replace the soil seed bank; these methods include, ploughing just after finishing to harvest the crops and pre-plant weed control (Fanadzo, *et al.*, 2010).

In other areas of sub-Saharan countries, poor weed control is influenced by insufficient labour for farming activities; because, majority of smallholders depend on labour-intensive weed control using hand hoes (Muoni, *et al.,* 2013). Usually, the shortage of labour supply occurs in the initial stages of crop development when weeds need to be controlled (Omovbude and Udensi 2012). For the effective weed control, using hand

hoes may need up to four weeding times in one cropping season; hence, insufficient labour may result to low maize yield because the growth of maize crops will be highly affected by weeds (Muoni, *et al.*, 2013). Also, untimely weeding may result to severe crop losses (Omovbude and Udensi 2012). In Zimbabwe, weeding is done depending on rainfall pattern and the level of weed infestation; normally it is done two - three weeks after germination and then once or twice in a season (Makuvaro *et al.,* 2014).

Low income to smallholder farmers is another challenge which constraint maize production. It holds back the application of modern farming techniques by smallholder farmers. Due to financial constraint, majority of farmers fail to use inputs like fertilizers, hybrid seeds and modern ploughing tools like tractor. This is evidenced in Abuja Nigeria where farmers failed to use tractors due to high hiring costs (Julius, 2014). Also, in Cameroon, smallholder farmers were not able to use organic fertilizer (manure) consistently because of transportation costs (Yengoh, 2012). In Local Government area of Kogi state Nigeria, farmers faced with the problem of maize hybrid seeds so they had to retain some proportion of harvests with the aim of using in the following season as seeds, which resulted to poor maize yield (Opaluwa, *et al.,* 2015). Financial constraint not only affects the use of modern techniques but also influence the ability of the farmer in farm management. For instance, labour wages (in activities like weeding, harvesting and transportation of crops) and the storage of the maize produced. High cost of labour indicates the unavailability of labour (Aduba *et al.,* 2013).

Post-harvest loss is another challenge facing smallholder maize producers. It can be influenced by physical, biological, engineering/mechanical and socio-economic factors. Physical factors can be temperature and moisture content of the stored maize grains. Temperature can increase or decrease the drying rate of maize grains. After harvesting, moisture content of the maize stored will change. Higher moisture content may cause maize infestation with mould, fungi and other moisture loving insects; hence rapid deterioration of maize grains. Biological factors involve insects, birds, mites, rodents, wildlife and micro-organisms. They eat, contaminate and cause loss to the cultivated maize. Engineering or mechanical factors comprise of the types and efficiency of maize

harvesting tools, primary processing equipment, transport and storage structures to mention few. Socio-economic factors comprise of financial status of the farm household, farming, storage and marketing system (Folayan, 2013).

The other challenges facing maize farmers includes high cost of transportation, low price of maize, pests and diseases to maize, unavailability of market for maize, low access to extension services, low soil fertility, theft of crops, high price of hybrid seeds and poor quality of hybrid seeds. Soil fertility is another constraint which farmers in Burkina Faso and Southern Sudan are dealing with (Dao *et al.,* 2015; Aduba *et al.,* 2013).

2.5 Conceptual Framework

This study theorized food security as a dependent variable to household food accessibility (Figure 2). Household food accessibility is influenced by both the level of income available at a household, the quantity of livestock products and the quantity of maize produced. Moreover, the level of household income depends on the sales of livestock products, cash crops produced, maize produced and off-farm income. Specifically, this study focused on food security at household level. The reason for this is because; individual food security is likely to jointly be influenced by overall household food security. Hence, at household level, a household can be food secured depending on the quantity of maize produced by that particular household.

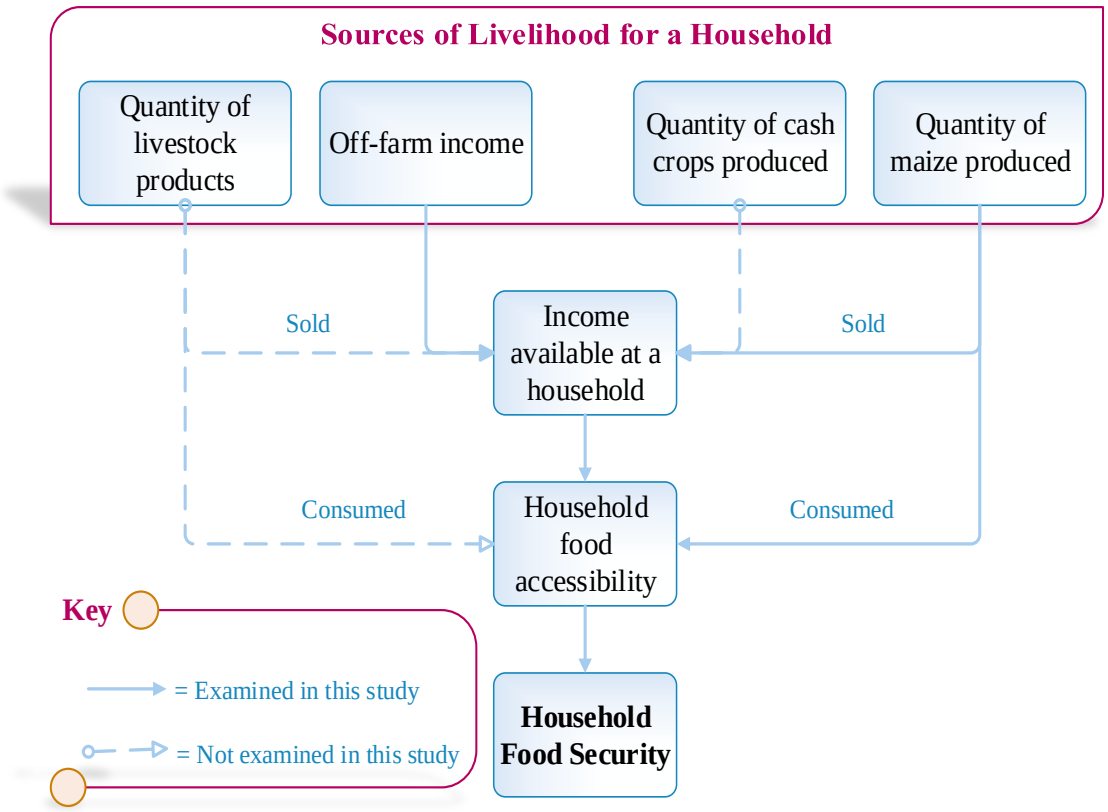

Figure 2: Conceptual framework for household food security

(Source: Modified from Frelata *et al*; 2015)

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Overview

This section presents the procedures used in data collection and data analysis. It starts by describing the study area. This is followed by research design and sampling procedures. Then data types and sources; data collection methods and tools are explained. Lastly it outlines data processing, analysis and presentation.

3.2 Study Area

The study was conducted in Babati District. The district lies between latitude 3^0 and 3^0 to the South of the Equator and longitude 35^0 and 36^0 to the East. The average annual temperature is 23^0C; July is the coldest month with a mean temperature of 15^0C and the warmest month is December with a mean temperature of 34^0C (Babati TC, 2013). This temperature is suitable for maize production since the crop can be produced in areas with mean daily temperature above 15^0C (FAO 2015). The district is nearby Arusha City (about 166 km), connected with the Great North Road. This provide easy accessibility to farmers in transporting their produce (maize) and to agro dealers of Babati in acquiring farming inputs. According to the 2012 national census, the district has a population of about 312,392 and 91.7% of the total households in the district are maize producers. Also, Babati district has a total area of 6,069 square kilometres (606,900 ha); whereby, 42.21% (256,163 ha) of the total area is planted with maize (URT, 2013).

The district is located in two agro-ecological zones of the rift valley highlands and the semi-arid midlands. It receives two rainy seasons; short rains from October to December and long rains from March to May with an average annual rainfall of 1200 mm; which is suitable for maize production since a medium maturity of maize requires 500 – 800 mm of water per season. Soils range from red sandy loam, grey sandy loams to red clay loams. Maize is susceptible to waterlogging hence it does well on very dense clay and very sandy soils that is well-aerated and well drained. Main crops grown include maize,

pigeon peas and food beans (FAO 2015; URT, 2013; Babati TC, 2013). The study was carried out in Babati district largely because it is one of the districts in Manyara region in which majority of households are smallholder farmers who depend on maize production for their livelihood; and that no study on contribution of maize towards household food security have been done.

3.3 Research Design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure (Kothari, 2004). The study used cross-sectional research design in data collection. Cross-sectional survey involved data collection from the population of smallholder farmers of Bagara ward in Babati District once on aspects of smallholder maize production towards household food security. Cross-sectional survey was desirable in acquiring information on the existing situation of maize production in the study area because, this method is inexpensive and takes little time to conduct.

3.4 Sampling Design

3.4.1 Sampling unit

Sampling unit is an elementary unit or the group or cluster that forms the basis of sampling process (Kothari, 2004). The main unit of analysis in this study was household heads who were involved in maize production. However, in case heads were not present, the representative (knowledgeable) such as spouse or elder son/daughter was interviewed.

3.4.2 Sample size

Sample size is the number of items to be selected from the universe to constitute a sample (Kothari, 2004). In this study, sample size was purposively selected in Bagara ward. At least 26 household heads in Ngarenaro, Bagara ziwani and Nakwa sub-wards were selected. So, the sample size involved 80 household heads.

Table 4: Sample unit and composition

S/no	Village/Sub-ward	Number of household heads
1	Ngarenaro	26
2	Bagara Ziwani	27
3	Nakwa	27
TOTAL		**80**

3.4.3 Sampling Procedures

A combination of multi-stage sampling, stratified sampling and purposive sampling was used. At stage one, Babati District was selected because it was ranked the first District in Manyara region with high number of maize producing households (URT, 2013). At stage two, Bagara ward was selected because it was ranked the second ward with high number of households in Babati District. At stage three, household heads in Bagara ward were selected using stratified sampling. The sample was stratified basing on sex of household head and age of the household head. Specific household heads included in the study were selected through purposive sampling because almost all households in Bagara ward depend on maize production as a means to access food.

3.5 Data Collection

Data collection is the accumulation of specific evidence that will enable the researcher to properly analyse the results of all activities by his research design and procedures (Singh, 2006). Methods used to collect primary data were observation, interview and Focus Group Discussion (FGD); and data collection tools used were questionnaire and checklist.

3.5.1 Primary data collection

Observation: Overt observation was used to watch the physical characteristics of the study area like farm sizes and the types of crops grown in the study area. It was also used in pilot study so as to provide an insight of an area and on how to use other data collection methods.

Interview: Unstructured interview was conducted to agro dealers, so as to acquire necessary information relating to prices, supply and demand for various inputs which influence maize production. Also, interview was done to other household members on production of food crops in a household, food consumption pattern and involvement of household members on farm and off-farm activities. All this information provided the basis in analysing maize production and food security status in the study area.

Focus Group Discussion (FGD): This is a structured discussion which is used to acquire in-depth information from a group of people about a particular topic (Gerritsen, 2011). Two focus group discussion were carried out in which two groups were formed purposively each consisted of eight members. The first group consisted of five men and three women. The second group consisted of five women and three men. All these groups discussed on the cost structure of maize production, farming tools used and revenue estimation from farm produce; additionally, the Focus Group Discussion aimed at acquiring information on food consumption pattern among households.

3.5.2 Development of data collection tools

Pilot study: A pilot study is a small study that helps in designing a further confirmatory study, by involving fewer respondents than the main survey. It aims to test the study procedures, validity of tools and estimation of parameters among others (Arain et al., 2010). In this study, the pilot study was done before the main field work in eight households of Bagara Ziwani; because, households in this sub-ward had similar characteristics like those of the other sub-wards in Bagara ward. The pilot study was conducted so as to test the questionnaire by improving its accuracy, consistency and validity of data; specifically, to determine if the items in questionnaire yield the information needed. It helped to generate a list of food varieties that were usually consumed by households in the study area so as to be arranged in a questionnaire.

The technique used during the pilot study was a face-to-face interview with some household heads and some individuals within the household. This technique was used since it is the best technique that normally provides data better than those acquired from

self-completion methods (McFarlane and Garland, 1994). The results of the pilot study did not affect much the final version of the questionnaire except in the arrangement of food varieties that were commonly consumed by households.

Generally, the data collection tools used were questionnaire and checklist.

i. **Questionnaire:** A questionnaire is defined as a document containing questions and other types of items designed to solicit information appropriate to analysis (Acharya, 2010). Structured questionnaire which included pre-coded questions on maize production and food consumption patterns at household level was used to acquire reliable information from household heads.

   The questionnaire was written in English language and it is neither first nor second language to the respondents in the study area; hence, the researcher read the questions and translated in Kiswahili. However, in some instances, there was a translation from Kiswahili to Iraqw language (mother tongue for majority of households in Babati district), since some household heads were more confident to express themselves in Iraqw than in Kiswahili. Therefore, a translation from Kiswahili to Iraqw was essential so as to ensure the correctness and validity of responses. This translation was done with the help from individuals within the households but Mr Musa Joseph Ghalo played a large part in translating.

ii. **Checklist:** This was used as a guide during interview and in Focus Group Discussions. It consisted of guiding questions that facilitated the acquisition of additional information relevant to the research objectives.

3.6 Data Processing, Analysis and Presentation

3.6.1 Data processing

The collected data was edited (to detect errors); coded (to put responses in a limited number of categories); classified (in homogenous groups) and then entered in computer programme Statistical Package for Social Sciences (SPSS) version 20.

3.6.2 Data analysis

Data analysis is the computation of certain measures along with searching for patterns of relationship that exist among data-groups (Kothari, 2004). Descriptive statistics (calculations of percentages, frequency, means and standard deviations) was used to analyse maize production in the study area. Household caloric acquisition (HCA) was used to determine the number of calories acquired by households from the consumption of maize; while Return on Investment (ROI) was used in income estimation from maize production. Also, the study used dietary diversity (DD) and dietary energy consumed (DEC) approaches to determine food security status in the study area.

3.6.2.1 Household caloric acquisition (HCA)

The study employed household caloric acquisition (HCA) to determine the number of calories acquired by household members from the consumption of maize over a period of seven days. The result was compared with the national average of energy acquisition from consuming maize. This method was selected because it produces a crude estimate of the number of calories available for consumption in the household; and the possibility that individuals will change their behaviour as a consequence of being observed is reduced since the questions are retrospective, rather than prospective (IFPRI, 1999). The following computations were used to determine household caloric acquisition from maize.

$$HHM_p = MB_p \times KG_{mb} \quad \text{..... (1)}$$

Whereby, $\mathrm{HHM_p}$ = Household maize production; $\mathrm{MB_p}$ = Bags of maize produced; and $\mathrm{KG_{mb}}$ = Kilograms per maize bag

One bag of maize has an approximately 100 kg (Suleiman and Rosentrater 2015).

$$HHF_p = HHM_p \times COR_m \quad \text{..... (2)}$$

Whereby, $\mathrm{HHF_p}$ = Household maize flour produced; $\mathrm{HHM_p}$ = Household maize production; and $\mathrm{COR_m}$ = Conversion rate of maize to maize flour.

According to Ranum *et al.* (2014), the extraction rate for maize ranges from 60 – 100 percent in most countries. This study used the extraction rate of 84%; implying that, 1 kg of maize yields 0.84 kg of maize flour.

$$HCA_m = HHF_p \times CAL_{mf} \quad \ldots\ldots (3)$$

Whereby, HCA_m = Household caloric acquisition from maize; HHF_p = Household maize flour produced; and CAL_{mf} = Number of calories from maize flour.

According to the Tanzania Food Consumption Tables as provided by Lukmanji and Hertzmark (2008), 1 kg of maize flour contains 3,620 kcal.

3.6.2.2 Income estimation from maize production

The study employed Return on Investment (ROI) method to measure the performance of household maize production. According to Botchkarev and Andru (2011), ROI is a performance measure used to evaluate the efficiency of an investment or to compare the efficiency of a number of different investments. In computing ROI, the benefit (return) of an investment is divided by the cost of the investment; and the result is expressed as a percentage or a ratio.

$$ROI = \frac{TR - TC}{TC} \quad \ldots\ldots (4)$$

Whereby, ROI = Return on investment; TR = Total revenue; and TC = Total cost.

The ROI of 100% suggests that, not only the return of the money invested in maize production but also gaining the same amount as a profit from maize production (Botchkarev and Andru, 2011).

3.6.2.3 Determination of food security status

The study used dietary diversity (DD) to determine different types of foods consumed by a household over a period of thirty days by using a weighted sum. The Household Dietary Diversity Score (HDDS) was calculated basing on different number of food groups because the scores were used for different purpose. One of the purpose was to provide an indication of household economic access to food; that is, food types that

require household resources to obtain (FAO, 2013). The weighted sum was calculated by assigning weights that reflected frequency of consumption of different types of foods. Hoddinott (2002) assigned letters J, S, M and R to represent the weights of scores. Letter J represent the weight of 24 (16 - 30 days in the last month) i.e at least every other day if not more frequently than that; letter S represent the weight of 10 (4 - 15 days of last month) i.e once or twice a week; letter M represent the score of 3 (1 - 3 days in last month); and letter R represent the score of 0 (0 days) i.e not at all.

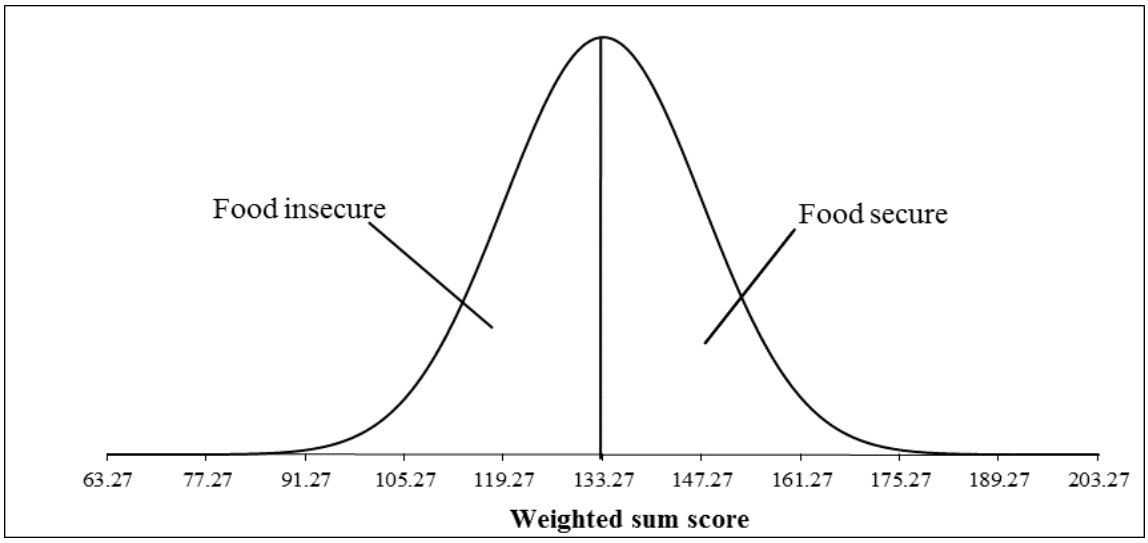

Figure 3: Household food diversity

According to FAO (2013), there are no established cut-off points in identifying the number of food groups that indicates adequate or inadequate dietary diversity. Hence, this study employed the method suggested by Swindale and Bilinsky (2006) and FAO (2008) in which it established a household dietary diversity score (HDDS) target by taking the average of 33% of households with the highest diversity (upper tercile of diversity). The average HDDS of 33% of households in the study area was 133.27. Hence, a household was categorised as food secure if the weighted sum score was above 133.27 or food insecure if the weighted sum score was below 133.27 (Figure 2).

Another method used in determining food security status was dietary energy consumed (DEC). By using this approach, the study measured food access and consumption per household from one 24-hour dietary recall. The study used the Tanzania cut-off point of

2,200 kcal per adult equivalent per day in measuring dietary energy consumption (DEC) (Wanmali and Islam, 2002). So, the household was considered food secure if it has consumed more than 2,200 kcal per adult equivalent per day and it was considered food insecure if it consumed less than 2,200 kcal per adult equivalent per day (Figure 4).

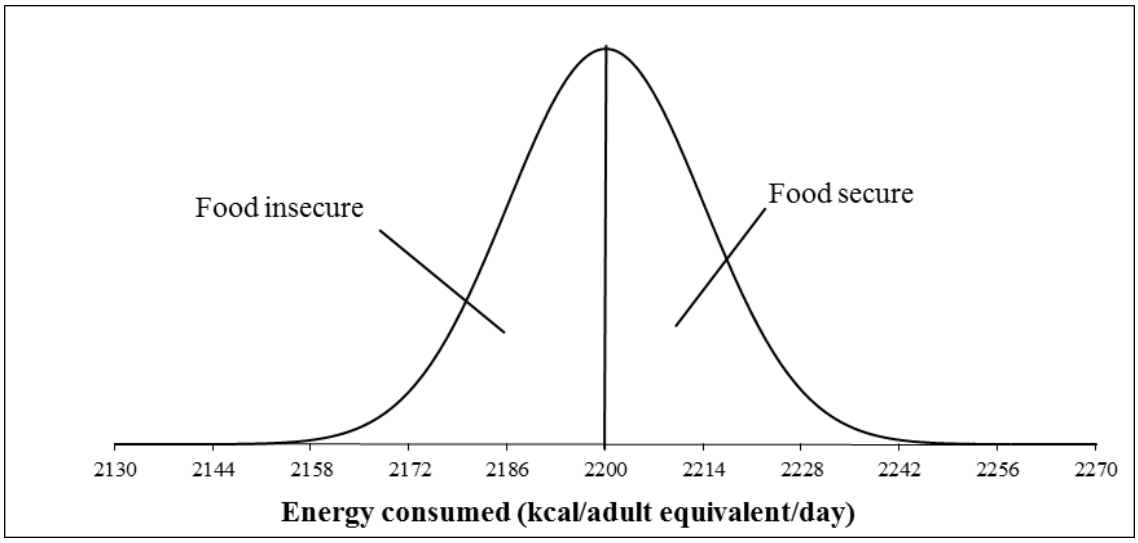

Figure 4: Household energy consumption

This method comprised the following computations;

Determining dietary energy consumed (DEC) by a household: DEC was calculated by recording various types and quantities of food consumed by household members in the last 24 hours. The quantity of food consumed was multiplied by energy contents of such particular food. Energy contents of various food items were used based on the Tanzania Food Composition Tables provided by Lukmanji and Hertzmark (2008) (Appendix 4).

$$DEC_h = QFC \times EFC \quad \text{..... (5)}$$

Whereby, $\mathrm{DEC_h}$ = Household dietary energy consumed per day; QFC = Quantity of food consumed; and EFC = Energy content of food consumed (kcal).

For example, if a household consumed 2 kg of rice and 1 kg of green pigeon peas per day. This is calculated by multiplying with 3,660 kcal (energy content per 1 kg of rice)

and 1,480 kcal (energy content per 1 kg of green pigeon peas) respectively. That is, (3,660 × 2) + (1,480 × 1) = 8,800. So, the household consumed 8,200 kcal per day.

Determining Adult Equivalent (AE) units: AE was calculated so as to identify nutritional needs basing on age and sex of household members. Constants on caloric requirement for different age group and sex (Appendix 1) were added to the age of each household member so as to find adult AE. The value of adult equivalent for each household member was added together to get AE units per household. AE units per household, represent the number of household members per household (household size). Then, the AE per household was adjusted by multiplying with average cost which is found in economies of scale constants table (Appendix 2). This is because it is assumed that, larger households need fewer amounts of resources per person due to sharing some facilities. The values of average cost decreases as the size of household increases.

$$HCAL_{as} = \sum CAL_{cos} \quad \text{....} \quad (6)$$

Whereby, $HCAL_{as}$ = Household caloric requirement basing on age group and sex; and $\sum CAL_{cos}$ = Sum of intra-household caloric requirement constants basing on age group and sex

$$AE = \sum HCAL_{as} \times AC_{hm} \quad \text{.....} \quad (7)$$

Whereby, AE = Adult equivalent units; $\sum HCAL_{as}$= Sum of Household caloric requirement basing on age group and sex; and AC_{hm} = Average cost per number of household members (economies of scale).

Household caloric requirements constants and household economies of scale constants (average cost) are according to Collier *et al*., (1990).

For example, if there are five people in a household, two men aged 30 and 12; and three women aged 25, 7 and 2. AE equivalent is calculated by adding 1, 0.8, 0.88, 0.64 and 0.4 caloric requirements for a 30-years man, 12-years man, 25-years woman, 7-years woman and 2-years woman respectively. The sum represents the number of individuals in a household. That is, 1+0.8 +0.88+0.64+0.4=3.72 adult equivalent units. The value

3.72 (approximately 4) represent the number of household members; hence it is multiplied by average cost in a household with 4 members. That is, 3.72 × 0.851=3.166. Therefore, the adult equivalent unit is 3.166.

Determining household DEC per adult equivalent per day: The value obtained (after multiplying AE per household with average cost) per household is used as a denominator of total number of energy consumed by a household and the output is called household dietary energy consumption (DEC) per adult equivalent per day.

$$DEC_{ae} = \frac{DEC_h}{AE} \quad \text{..... (8)}$$

Whereby, $DEC_{ae} =$ Household dietary energy consumed per adult equivalent per day; $DEC_h =$ Household dietary energy consumed per day; and $AE =$ Adult equivalent units.

For example, if energy consumed by a household is 8,200 kcal, then it is divided by household adult equivalent (AE). That is, $\frac{8200kcal}{3.166} = 2590.02kcal$. Hence, a household consumed 2,590.02 kcal per adult equivalent per day.

3.6.3 Data presentation

Tables, charts, graphs and text explanation statements were used to present the processed and analysed data results.

CHAPTER FOUR

PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Overview

This chapter presents the findings of the data collected from the study area relating to smallholder maize production towards household food security in Babati. The chapter begins by presenting, analysing and discussing results on household socio-economic characteristics and its influence in maize production. This is followed by factors influencing maize production in the study area like land size and ownership, maize cropping system, farming tools used and the use of labour in farming activities. Then, the chapter assess maize production basing on the quantity produced, production costs and revenue estimation. Moreover, it analyses and discuss the findings on household caloric intake from maize particularly the accessibility and consumption of food and the contribution of maize towards household food security. Lastly, the chapter highlights the challenges facing maize producers in the study area.

4.2 Respondents Characteristics

The main targeted respondents for the study were household heads of smallholder farmers in Bagara ward. A total of 80 household heads from three villages of Bagara ward were involved. The characteristic distribution of household heads included; age, sex, marital status, level of education and number of household members as indicated in Table 5.

It has been found that there is a relationship between age and household food security. According to Kumba (2015), the age of the household head has a significant impact on food security. The number of years of a farmer can be linked with experience that he has in farming. The older the farmer, the more experienced he/she is and the better his understanding of farming practices, experience on social and physical environment, experience on farming activities, land accessibility, physical ability and off-farm income (Aduba *et al.,* 2013). The results in Table 5 indicate that 51.25% of household heads

were aged between 20-39 years and 41.25%were aged 40-59. This implies that at least 50% of household heads in the study area are experienced maize farmers since basing on their ages, they have produced maize for more than ten years. Correspondingly, majority of household heads (92.5%) are aged less than 60 years. This is the age in which individuals are expected to be physically energetic in production activities particularly farming. Moreover, the findings in Table 5 show the cross tabulation between age of household head and maize production, the proportion of households with maize production more than 1000 kg was low (11.3%) for 20-39 year age category, then increased to 23.3% for household heads aged between 40 and 59 but declined further for household heads with more than sixty years. This implies an increase in maize production with an increase in the age of a household head though the production declines at some stage of elderly. Hofferth (2003) conducted a study which had similar results. He argued that the higher the age of the household head, the more stable the economy (food security) of the farm household, because older people have richer experiences of the social and physical environments; have greater experience of farming activities; and have better access to land than younger heads (because younger men either have to wait for a land distribution, or have to share land with their families). Also, Arene and Anyaeji (2010) argued older household heads to be more food secure than the younger ones because they are more knowledgeable in farming activities.

The sex of the household head is an important factor in households because it influences farm organization and income earning opportunities of a household which in turn determines household food security (Kumba, 2015). The results in Table 5 indicate that 60% were male headed households (MHHs) and 40% were female headed households (FHHs). For MHHs the results (Table 5) show that 33.8% produced between 100 and 1000 kg of maize and 22.5% produced more than 1000 kg; for FHHs, 25% produced between 100 and 1000 kg and 10% produced more than 1000 kg. By comparing MHHs and FHHs, the results indicate that there was high proportion (22.5%) of MHHs which produced more than 1000 kg of maize during the last season as compared to FHHs (10%). The reasons for this might be among other, women have low access to land and

they are constrained by insufficient funds to invest in farming activities hence they are forced to cultivate small farms. This is in line with the study done by Auma *et al.*, (2010) in Homa Bay Kenya which found that women cultivated smaller plots compared to available land resulting in low quantity of produce in general and that women were found to be engaged in many off-farm economic opportunities with little stream of incomes which may not adequately compensate or support farm activities, hence resulting in loss of yields. Also, Yengoh (2012) found that female managed farms in Cameroon, recorded lower yields compared to male managed ones in small-scale food crop farming systems due to variations in the use of factors of production (inputs and management). Moreover, the study done by Bethelhem and Stein (2008) on difference in maize productivity between male- and female headed households in Uganda found that, average productivity of maize is lower for female-headed households than male-headed households due to gender-linked difference in resource.

The results in Table 5 show that majority of respondents were married (80%) and only 20% were single (these included widows/widowers, divorced and separated). Also, 46.3% of married farmers produced 100-1000 kilograms of maize and 27.4% produced more than 1000 kilograms. Likewise, majority of single farmers (12.5%) produced 100-1000 kilograms of maize and 5% produced more than 1000 kilograms. This implies that the married household heads had a higher maize production than single household heads. This might be because, in most married households, a household head had a responsibility to feed a number of individuals within the household who depended on him/her to acquire basic needs including food. So this made them to work hard on food production so that they can fulfil their responsibility of feeding the household. Also, Umar and Kamsang (2014) in their study in Kano and Katsina States Nigeria, they concluded that married farmers have high maize production than single (unmarried) farmers due to the fact that the married have more responsibilities to shoulder in terms of providing basic need of their family with food being the most important. Therefore, any technology that will increase the production of food or provide likelihood of food security for his/her family will be adopted.

Table 5: Respondents socio-economic characteristics and maize production (n=80)

Characteristic of household head	Categories	< 100 kg	100-1000 kg	>1000 kg	Total
		F (%)	F (%)	F (%)	F (%)
Age	20-39	4(5)	28(35)	9(11.3)	41(51.25)
	40-59	3(3.8)	13(16.3)	17(21.3)	33(41.25)
	60+	0(0)	6(7.5)	0(0)	6(7.5)
Sex	Male	3(3.8)	27(33.8)	18(22.5)	48(60)
	Female	4(5)	20(25)	8(10)	32(40)
Marital status	Single	1(1.3)	3(3.75)	0(0)	4(5)
	Married	5(6.3)	37(46.3)	22(27.4)	64(80)
	Widow/Widower	1(1.3)	6(7.5)	3(3.75)	10(12.5)
	Divorced/Separated	0(0)	1(1.25)	1(1.25)	2(2.5)
Education level	Primary school	5(6.3)	38(47.5)	19(23.8)	62(77.5)
	Secondary school	0(0)	6(7.5)	3(3.75)	9(11.25)
	Tertiary education	0(0)	0(0)	1(1.25)	1(1.25)
	Not attended school	2(2.5)	3(3.75)	3(3.75)	8(10)
Number of household members	1 - 4	3(3.8)	24(30)	3(3.75)	30(37.5)
	5 - 8	4(5)	23(28.8)	19(23.8)	46(57.5)
	9 - 12	0(0)	0(0)	4(5)	4(5)

Education has been known to be a powerful tool for shaping people's life and making life meaningful, even at adult age. It is argued that, increased agricultural productivity depends primarily on the education of the rural farmers to understand and accept the complex scientific changes which are difficult for the illiterate rural farmer to understand (Okpachu *et al.,* 2014). Hence, a high level of education is expected to be associated with high crop production and of higher value (Minot *et al.,* 2006). The findings regarding the education level of a household head revealed that three quarters of household heads (77.5%) had primary education, and only 1.25% had tertiary education (Table 5). This implies that households in the study area are expected to be able to acquire new skills that will enhance them to increase maize production because majority (90%) of household heads had formal education. However, 55% of farmers with formal

education (primary school to tertiary education) produced 100 - 1000 kilograms of maize and 28.8% produced more than 1000 kilograms of maize per season; whereas, only 6.3% of household heads with formal education had maize production of below 100 kilograms. This imply that education level of household head is likely to have contributed to maize production by enabling farmers to know the socioeconomic and environmental circumstances that leads their farming undertakings and understand easily the directives from extension officers. The same results were obtained by Okpachu *et al.* (2014) in which on their study in Yobe state Nigeria, they found that education contributed to farm productivity as it had a positive effect on the adoption of innovations. Also, the study conducted by Mulinga (2013) in Rwanda proved the same that education had a big role in improving farmers' efficiency (input-output ratio).

The number of household members (household size) is also an important factor for household food production. This is because it serves as an indicator for labour supply since majority of smallholder farmers depends on family labour for farming activities (Smale, 2011). Table 5 indicate that more than half (57.5%) of households had 5-8 members, 37.5% had 1-4 members and 5% had 9-12 members. Furthermore, the study area had an average household size of 5.7 members per household; this is almost the same with the regional average household size of 5.2 members (URT, 2012). Comparing these results with the results obtained in various studies like Aduba *et al.* (2013), household size in the study area was average meaning that some of the farmers (who are financially capable) had to employ extra few labour for farm activities like weeding, harvesting and transportation. In terms of maize production, 30% of households with 1 - 4 members produced between 100 and 1000 kilograms of maize and 3.75% produced more than 1000 kilograms; whereas for households with 5-8 members, 28.8% produced 100 to 1000 kilograms of maize and 23.8% produced more than 1000 kilograms of maize. This observation implies that households with larger number of people had high maize production. This might be because they had enough labour power at household which influenced the supply of labour for maize production. Hence, high family size results to high number of labour-force and thereafter leads to more maize production.

The study conducted by Umar and Kamsang (2014) in Kano and Katsina States Nigeria, found that the size of the household was one of the most important factors conditioned the level of production and productivity of small scale farmers. This is because, the relatively large family size of the family is an obvious advantage since it may likely enable farmers to use family labour, thereby reducing labour cost in maize production. Other studies disagree that a large family size contributes to high farm production; for example, the study done by Achem, *et al.* (2013) in Kwara State Nigeria found that low overall output from cassava farmers was a result of large family size.

4.3 Factors Influencing Maize Production

4.3.1 Land size and ownership

Land is the main physical asset of poor farmers (Juma *et al.,* 2009). It is one of the important resources to farmers in all farming systems because it provides areas for cultivation of crops (REPOA, 2010). Its contribution to farmer's income is far more important than physical capital (Juma *et al.,* 2009). So the availability and accessibility of land is important to farmers' livelihoods (REPOA, 2010). The results (Table 6) indicate that, majority (95%) of household heads in the study area, cultivated a farm(s) that was owned by the household and few (5%) of household heads hired a farm(s) for maize cultivation. This could be because many households are indigenous of Babati hence they inherited the land from their ancestors but those who have migrated from other areas (public servants, business persons) plus those who wanted to increase the size of their farm land for maize cultivation, were forced to hire the land.

The results in Table 6 reveals that 62.5% of households cultivated a farmland of 1 to 2 acres, 18.75% cultivated below 1 acre, 15 cultivated 3 to 4 acres and 3.75% cultivated 5 to 6 acres of land. This observation implies that food production in the study area is at small-scale that is why majority of households had small farms; and it also means that majority of farmers in the study area are subsistence farmers. The reason for this could be because majority of farmers have low income so they are not capable to invest in large scale maize farming. Aduba *et al.* (2013) found that, in Kogi state Nigeria,

majority (87.8%) of farmers were small scale farmers (cultivating 2.5 – 6.25 acres). They point out that the reason for this was due to long distances to farm site, high cost of land, high cost of labour and low income level.

Table 6: Households' farm size and maize production (n=80)

Characteristic	Categories	<100 kg Frequency	100-1000 kg Frequency	>1000 kg Frequency	Total Frequency
Farm size (acre)	<1	5(6.3)	10(12.5)	0(0)	15(18.75)
	1 - 2	2(2.5)	32(40)	18(20)	50(62.5)
	3 - 4	0(0)	4(5)	8(10)	12(15)
	5 - 6	0(0)	1(1.25)	2(2.5)	3(3.75)

Figures in brackets indicate percentages.

Additionally, the results (Table 6) illustrate that higher proportion (64% or 10 HH out of 15 HH) of households that owned 1-2 acres of land produced between 100 and 1000 kg of maize and 36% (18 HH out of 50 HH) produced more than 1000 kg of maize; whereas, for households that owned (cultivated) 3 – 6 acres of land, 66.7% of them produced more than 1000 kg of maize and 33.3% produced between 100 and 1000 kg. This implies that maize production increased with an increase in farm land. This observation complies with the study done by Baha (2013) in Babati which found that, the size of the farm matters as far as increasing maize production is concerned. Also, same results were obtained by Aduba *et al.* (2013) that small farms have led to low maize production in Kogi state Nigeria.

4.3.2 Maize cropping system

Babati district meets its food requirements mainly through its own production (REPOA, 2011). The main food crops grown in the study area were maize, beans and pigeon peas (habitually, the green pea is consumed for food and the dried pea is sold); though there are few farmers who cultivate sorghum and millet. Mixed cropping was the most common cropping system in Babati whereby almost all (98.75%) farmers planted various food crops simultaneously in the same farm. The pattern of planting was that; one maize row was followed up by one leguminous crop (pigeon peas or beans) row.

This system of intercropping is dissimilar to that found in highlands of Central Kenya by Muna *et al.* (2010) whereby, one row of maize is alternated by one legume row; and another way was that in which two maize rows are alternated by two legume rows. The results in this study indicate that, majority (70%) of households preferred a mixed cultivation of both maize and pigeon peas; 22.5% cultivated maize, pigeon peas and beans (for this, beans is either planted in a separate plot of land or intercropped with maize only); 6.25% cultivated maize and beans; and 1.25% cultivated maize only (Figure 5). This implies that mixed cultivation is dominant in Babati and households prefer mostly the intercropping of maize and pigeon peas for food and for income generation. The possible reasons for this can be to utilize the land to the maximum degree; to increase the total productivity; and to have an alternative crop to meet household's food requirements and/or to compensate the costs incurred in farming especially through the sales of pigeon peas. Similarly, Aduba *et al.,* (2013) found that majority (94.7%) of farmers in Nigeria were doing intercropping farming system so as to minimize cost of production in order to maximize profit and also security against crop failure. Also, Muna *et al.* (2010) found that, increasing crop productivity and effective utilisation of land were the main reasons for intercropping in Highlands of Central Kenya.

Furthermore, the study found that despite majority of farmers were doing intercropping system in their farming system, maize production was average in the study area since 46% of households produced between 100 and 1000 kg of maize and 26% produced more than 1000 kg. This quantity of production can be due to availability of low rainfall especially in critical times like flowering and grain filling among other factors. This is contrary to the study done by Olaniyan (2015) and Muna *et al.* (2010) which found that intercropping resulted into an increased maize production even in drought prone-areas of Nigeria and Kenya respectively.

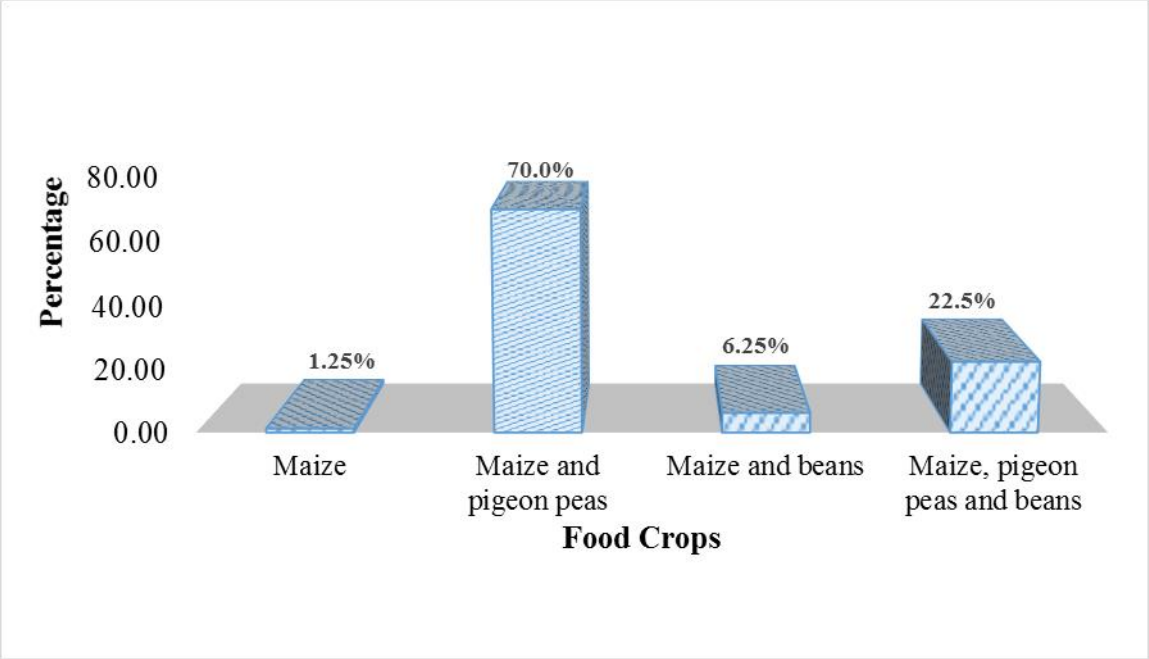

Figure 5: Major crops grown by households

4.3.3 Farming tools used

The type of tool used for farming activities is also an important factor that can influence maize production. The study found that, 61.25%, 30% and 8.75% of households utilised plough, tractor and hand hoe respectively for farming activities (Table 7). Plough had the highest proportion of households that utilised it in farm preparation and planting. This implies that, it was the most widely used farming tool in the study area. The reason for this could be due to easy availability and its affordable cost than that of hiring a tractor. Additionally, animal power (ox-cart) was the major means of transporting crops from the farm to the residence; the other transportation means used were tractor, motorcycle, tricycle and labour. Similarly, Beshir and Wegary (2014) found that, the use of animal power in Ethiopia was influenced by availability of nearly a pair of oxen sufficient to cultivate small farms owned by households. Hand hoe was used almost by all households in the study area in weeding; though, some (8.75%) households use it in farm preparation and planting.

The results in Table 7 indicate that, 21.5% of the households that used plough produced more than 1000 kg of maize. Proportionally, 37.5% of the total households that used tractors produced more than 1000 kg of maize and 34.7% of total households that used plough. This implies that tillage of the farm using tractors results to better maize yield. This could be because tractor enhances deep ploughing than using animal power (plough); this may help to reduce weeds. Kibaara and Kavoi (2012) found that the use of tractors ensured timely farm preparation, planting and weeding among maize farmers in Kenya hence influenced maize yield.

Table 7: Farming tools used and maize production

Farming tool	**<100 kg**	**100-1000 kg**	**>1000 kg**
	Frequency	Frequency	Frequency
Tractor	1(1.25)	14(17.5)	9(11.25)
Plough	3(3.75)	29(36.25)	17(21.25)
Hand hoe	5(6.25)	2(2.5)	0(0)

Figures in brackets indicate percentages.

4.3.4 The use of labour in farming activities

Labour plays a key role in household's food production. It is more important in smallholder farming where almost all activities are conducted manually. In most cases, what matters in the use of labour in smallholder farming is the quantity of labour rather than the quality (skills or education level). A household can rely on family labour, hired labour or a combination of both.

The results as presented in Table 8 indicate that 72.5% of household heads responded that household labour was not enough to implement all farming activities, 27.5% responded that household labour was enough. Again, 68.75% of households used hired labour for farming activities and 31.25% did not use hired labour. As it can be observed in Table 8, there were some (3.75%) household heads who responded that household labour was not enough for farming activities but they did not use hired labour. The reason for this is could be due to financial constraints, having a small farm or low crop

production which did not require high number of labourers. Besides, 28.75% and 18.75% of households used 1-5 and 6-10 hired labour respectively. There are also households (11.25%) that hired more than 16 labourers. It should be noted that even if a household uses hired labour, still household members (adult/non-schooling) will also take part in some farming activities.

Table 8: Household's use of labour for farming activities (n=80)

Variables		Frequency (%)
Household labour	Enough	22(27.5)
	Not enough	58(72.5)
Use of hired labour	Yes	55(68.75)
	No	25(31.25
Number of hired labourers	0	25(31.25)
	1-5	23(28.75)
	6-10	15(18.75)
	11-15	8(10)
	16+	9(11.25)

In a FGD, farmers responded that for households with few household members or if majority of household members are young, they tend to be supported by their relatives. Despite the role played by household members in farming activities, it is clear that they cannot fulfil all the tasks on their own because majority of households used hired labour. Also, the use of hired labour in the study area was influenced by income level of household heads. This is similar to the study done by Takane, (2008) who found that hired labour was used by smallholder farmers in Malawi when a household had insufficient family labour that can complete the farm activities. Bedemo *et al.* (2013) argued that, the demand for hired farm labour is influenced by off-farm income (of a household head), number of dependants and size of the cultivated land.

There are a number of activities involved in maize production that were done manually using labour power. The result in Table 9 indicate the number of labourers used by

households in various activities in maize production in which, 39.92% and 46.7% of household members and hired labourers respectively were used in weeding; 50.84% and 52.3% of household members and hired labourers respectively were also used in harvesting. Ploughing required a minimum number of labourers. This imply that, there were farm activities involved in maize production which were usually done manually hence required high number of labourers; for instance, weeding and harvesting.

Weeding and harvesting were the most essential farm activities that required high number of labourers and at a right time. The reason for this was to avoid the maize plants to be affected by weeds at earliest stage; and also to avoid crop theft (when it is not yet harvested). Ploughing did not require high number of labour because it was done through the use of tractor or plough (animal power); but, in few cases, farm preparation was done manually through the use of hand hoe especially for households with a small farm and were financially not capable to hire neither a tractor nor animal power. Transportation of crops from the farm was done by the use of tractor or ox cart. Human labour was used to carry the crops from the farm and load on the tractor/ox cart. Though, in some instances human labour was used to shift the crops from the farm to the household residence especially for households to whom their farms were near to their homes. This is similar to the study done by Takane, (2008) who found that farm activities in maize production that required much labour were land preparation, weeding and harvesting.

Table 9: Number of labourers used in maize production

Activity	Number of household labour	Number of hired labourers
Ploughing	22(9.24)	5(1)
Weeding	95(39.92)	226(46.7)
Harvesting	121(50.84)	253(52.3)
Total	**238(100)**	**484(100)**

Figure in brackets represents percentage proportional

Hired labourers used for farming activities were mostly casual day labourers. They were not employed permanently by a certain farmer. There were two forms of wages used by

farmers to pay hired labourers; the first one was that in which labourers were paid according to the specific time they have spent doing a particular farm task and the second one was that in which labourers were paid after the completion of particular activity. These two forms of wage payment were used according to the nature of work that was to be performed. Takane, (2008) found two types of hired labour in Malawi which were, seasonal labour (labourers who were employed for several months in the rainy season) and task-contracted casual labour (wages were paid after completing a certain task).

4.4 Household Maize Production in Babati District

4.4.1 Quantity of maize produced by households

Figure 6 indicate that majority (58.75%) of households produced between 100 and 1000 kg of maize for 2014/15 season and 8.75% produced less than 100 kg. This implies that the general production of maize in 2014/15 was low. Also, the maximum and minimum maize production in the study area was 3500 kg and 0 kg respectively. This shows a huge difference in farm produce among the households and that some household got nothing despite the inputs used in maize production.

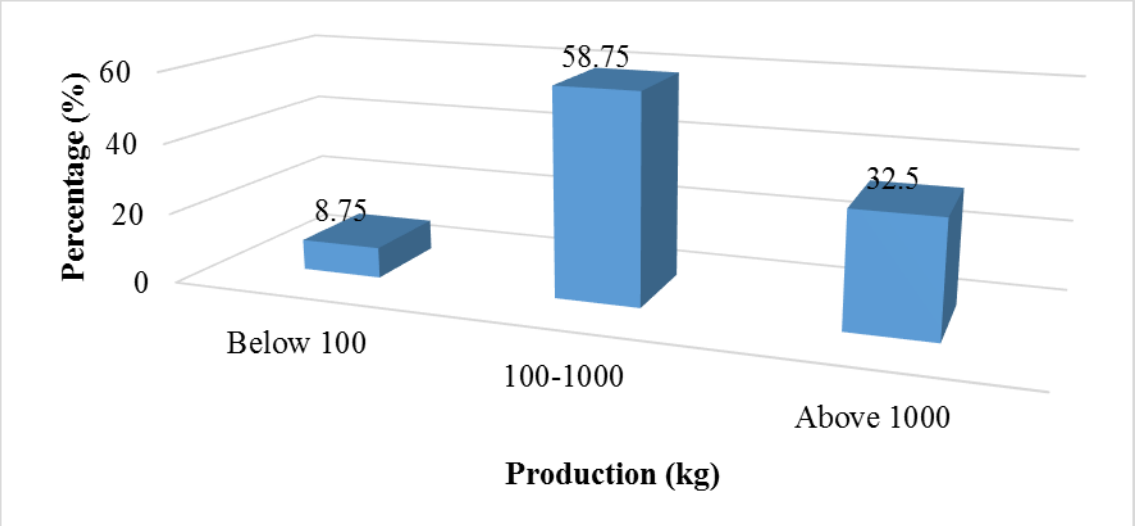

Figure 6: Quantity of maize produced

As it has been explained in previous subsection that maize is the major crop grown in the study area; hence, its yield has a great influence on the livelihood of many households who depend on subsistence farming because it impacts not only the availability of food in a household but also the level of income. The results in Table 10 indicate that, the maximum and minimum maize yields were 1500 kg/acre and 0 kg/acre respectively; and the average maize yield was 509.72 kg/acre. The average maize yield in the study area was low compared to the national average yield of 641.64 kg/acre (FAOSTAT, 2015). The results also indicate that there was a big difference (1500 kg/acre) between a household with high maize yield and that with low maize yield.

Generally, the low maize production and yield in 2014/15 production season could be influenced mainly by insufficient rainfall. Omoyo *et al.* (2015), found that climatic condition had the worst impact on maize yield in semi-arid lands of Eastern Kenya. Household socioeconomic characteristics could influence maize yield. Other reasons were raised in a Focus Group Discussion (FGD) that delaying to plant, late weeding and crop destructions caused by hippos were the other causes for low maize productivity. Similarly, Yengoh (2012) found that, inputs to agriculture, techniques of crop cultivation and socio-cultural characteristics of farming households were the reasons for low yield in small-scale farming in Cameroon.

Table 10: Average maize yield

Variables	Unit of measure	Mean	Maximum	Minimum
Production	kg	957.80	3500	0
Area harvested	acres	1.8	5	0.25
Yield	kg/acre	509.72	1500	0

4.4.2 Maize production costs

The costs incurred by farmers in maize production were associated with expenditures on maize hybrid seeds and fertilizer; also in activities like ploughing, weeding and harvesting. The results in Table 11 indicate that, the expenses from purchasing maize

seeds accounted 30.44% of total cost in maize production. This could be due to high anticipation among households of having high yields from the use of hybrid seeds than using local seeds; hence, despite its price, farmers were willing to purchase hybrid seeds. This is dissimilar to the study done by Assa et *al.* (2014) in Malawi that, the purchase of fertilizer by farmers was more important than the purchase of improved seeds. The cost of a 2 kg maize hybrid seeds ranged from 8,000 – 12,000 Tshs. The use of hybrid seeds ranged from 2 kg to 80 kg. This suggests that there was high supply of hybrid seeds and farmers were willing to purchase; also, majority of farmers have shifted from traditions of using local seeds by keeping some portion of their harvests as seeds for the coming season.

During the interview, household heads explained some of the criterion that they used in selecting hybrid seeds, but the basic criteria by most of the household heads was based on yields of that particular hybrid seed (sacks of maize per acre). They preferred hybrid seeds with greater returns. Some of them responded that, they preferred maize hybrid seeds with early maturity especially in seasons in which they expected low rainfall and also depending on planting time (early or late). The types of maize hybrid seeds that were mostly used by many households were locally known in Swahili names. These were; *chapa simba (SC 627)*, *chapa pundamilia* (SC 513) and *chapa tumbili* (403) which are owned/maintained by East African Seed Company and other varieties of maize hybrid seeds maintained by Pannar Seed Company. Dao *et al.* (2015), found that maize yield of particular hybrid seed was the major criteria used by farmers in selecting the maize varieties in Burkina Faso. But they also found other criterions which were; grain colour, grain size and the cycle of maturity.

The costs incurred by farmers from the use of fertilizer accounted 3.23% of the total maize production cost (Table 11). This is the minimum expenditure item incurred by farmers; and it suggests that, the use of fertilizer in the study area is low. This could be influenced by the fact that majority of households are constrained by low income hence, the use of fertilizer was not their priority; they were not willing to incur additional costs in fertilizer application. The national sample census on agriculture also reported that, the

use of fertilizer in Manyara region was very low (8.1% of the total area planted with annual crops); and regarding the planted area with fertilizer application, organic fertilizer and inorganic fertilizer accounted for 95% and 5% respectively of the total area planted with annual crops in the region (URT, 2012). Sadiq *et al.* (2013) found that in Niger state Nigeria, the use of fertilizer was ranked the second in terms of expenditure items among maize producers accounting 16% of total cost. According to Urassa (2015), the limited use of fertilizer among maize producing households in Rukwa region was due to its unavailability and price constraints.

Table 11: Maize production costs

Expenditure item	Mean (TSHS/acre)	Percentage of total cost
Seeds	36,111.88	30.44
Fertilizer	3,836.46	3.23
Ploughing	49,722.22	41.91
Weeding	18,831.63	15.87
Harvesting	10,140.11	8.55
Total	**118,642.29**	**100**

On average, 308.85 kg/acre and 1.06 kg/acre of organic fertilizer and inorganic fertilizer was used respectively. This suggests that despite the low cost and easy availability of organic fertilizer (manure), it was used inconsistently in low quantities among households and from one season to another. This was influenced by the location of the farm (distance from household's residence to the farm) and the level of household's income at particular production season. Yengoh (2012) found that, the adoption and use of organic fertilizer is neither consistent nor optimized. He added that, the bulkiness of material (organic fertilizer) and transportation costs discourage this means of fertilization.

The use of animal power and tractor were the major means used in land cultivation. The results in Table 11 indicate that, the average cost of ploughing was 28,061.92 TSHS per acre (41.91% of total cost). This is dissimilar to the results from Zalkuwi *et al.* (2014)

who found that, ploughing accounted 14.7% (USD 16.8) of the total maize production cost per hectare in Adamawa state Nigeria. Ploughing cost in the study area was greatly influenced by high use of animal power (68.3%) than the use of tractor (31.7%) in land cultivation. The reason for this could be due to easy availability and the affordable cost of hiring animal power than that of hiring a tractor. The cost of using animal power and tractor ranged from 25,000 - 35,000 TSHS and 35,000 - 50,000 TSHS respectively per acre. Julius (2014) found that, in Abuja Nigeria, farmers implemented most of the farm activities manually because they were not able to afford the costs of hiring tractor services; and also because the accessibility of tractors was poor. In a FGD, some farmers hinted that, normally the owners of tractors in Babati do not prefer to work on small farms due to fuel and labour economy; unless farmers who have small plots of land that are near to each other, organise themselves to hire the equipment. This is different from hiring animal power because they can work even in smaller farms like 0.25 acre.

Weed control is one of the crucial maize production activities since it might influence maize yields (Muzari, *et al.,* 2012). Hence, households devoted their time and financial resources so as to avoid crop loss. Table 11 indicates that, weeding accounted 15.87% of total maize production cost in the study area during the last season (2014/15). Hand-hoeing was the most common type of weeding in the study area. Household labour was involved in weeding but in most cases, household labour was utilised. Discussions in FGD revealed that, the cost of hiring one labour for weeding ranged from 32,000 – 48,000 Tshs per acre.

Maize harvesting was another farm activity that households incurred cost in maize production. It accounted 8.55% of the total production cost. Both household labour and hired labour was involved in harvesting maize. The study found that, payment of wages to hired labourers was based on the time spent by a labourer on maize harvesting. The wage ranged from 2,000 – 5,000 Tshs per five hours.

4.4.3 Revenue estimation from maize production

The growth of smallholder farming can help the rural households to raise their incomes and reduce the costs of food expenditures (Salami, 2010). The production of maize by households may not be for the aim of meeting household food requirements only. Households may wish to raise income by selling some proportion of their produce. Table 12 indicate that the average variable cost in maize production per one acre was 119,417.26 Tshs and the average revenue per one acre was 254,860.69 Tshs. Also, the average Return on Investment (ROI) of 44.1% means that, from maize production, households earned 44.1% on costs per one acre. This implies that, maize production in the study area was slightly profitable to the households in terms of revenue generation. Maize production in the study area was on small scale but the high production cost was largely influenced by ploughing of the land. Osugiri, *et al.* (2012), found that in Southern-eastern Nigeria, smallholder farmers accumulated a low net profit from farming due to high production cost which was largely influenced by high labour cost despite population increase; and low use of fertilizers and pesticides which lowered productivity.

Table 12: Average cost and revenue from maize production

Variables	Unit of measure	Mean	Maximum	Minimum
Estimated cost	Tshs/acre	119,417.26	272,000	12,000
Estimated revenue	Tshs/acre	254,860.69	750,000	0
ROI	Percentage	44.10	95	0

Despite the slight profitability of maize to the households, only few (33.75%) households sold some proportion of their produce (maize). It suggests that, households were willing to sell some portion of maize they produced only after being sure that the production will meet household food requirements or when there is a high maize production. According to Urassa (2015), commercialisation of staples can be linked with higher productivity. However, some household heads responded that sometimes they

were forced to sell some portion of maize to generate income to buy other varieties of food and non-food stuffs like medical expenses, cloth and water expenses. Mashamaite (2014) also found that households in Limpopo province sold some part of their produce so as to generate income for various household expenditures.

The result as presented in Figure 7 indicate that majority (11.25%) of households who sold maize acquired an income of between 200,001 - 400,000 Tshs. In a Focus Group Discussion (FGD), the study revealed that there was no uniform price for maize since farmers sold their produce (maize) in different prices. Farmers responses showed that, one bag (approximately 100 kg) of maize was sold in a price ranged from 35,000 - 60,000 Tshs. One farmer hinted that, usually the maize price raises when traders from Kenya came to Babati to buy some quantity of maize so as to transport it to Kenya. He added that, sometimes these traders buy maize even when it is still at farm (not harvested) by lobbying farmers with an attractive (higher) amount of money. This was done by just approximating what will be the possible quantity (in bags) of maize output. This suggests that farmers had little control over prices of their produce (maize). Selling maize in this form does not guarantee a high price to farmers; this is because, sometimes the estimates of the produce may be underestimated hence farmers may incur loss. Aduba *et al.* (2013) found that, normally farmers (Nigeria) have no control over decisions on at what price to sell their maize output because there is no guaranteed market for them.

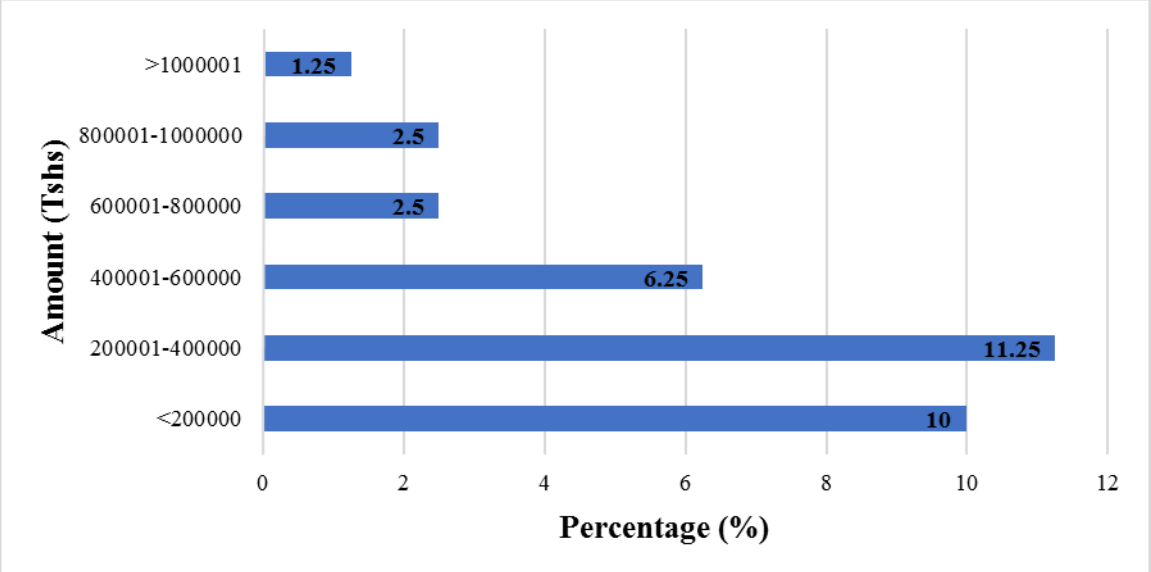

Figure 7: Revenue accrued from maize sales

4.5 Household Caloric Acquisition from Maize Consumption

4.5.1 Household food accessibility

Food accessibility is one of the key determinants of food security at household level. The accessibility of food at household level primarily depends on household's ability to produce food crops. The study found that maize was the major cereal consumed by households. The results (Figure 8) indicate that almost all (96.25%) households in the study area had three meals per day and very few (3.75%) who consumed less than three meals per day. This shows that majority of households were capable to meet three meals per day. Additionally, when asked on the source of maize flour consumed by a household in the last seven days, 56.25% of households responded that the maize flour consumed was from own (household's) production and 43.75% responded that they purchased maize from the market.

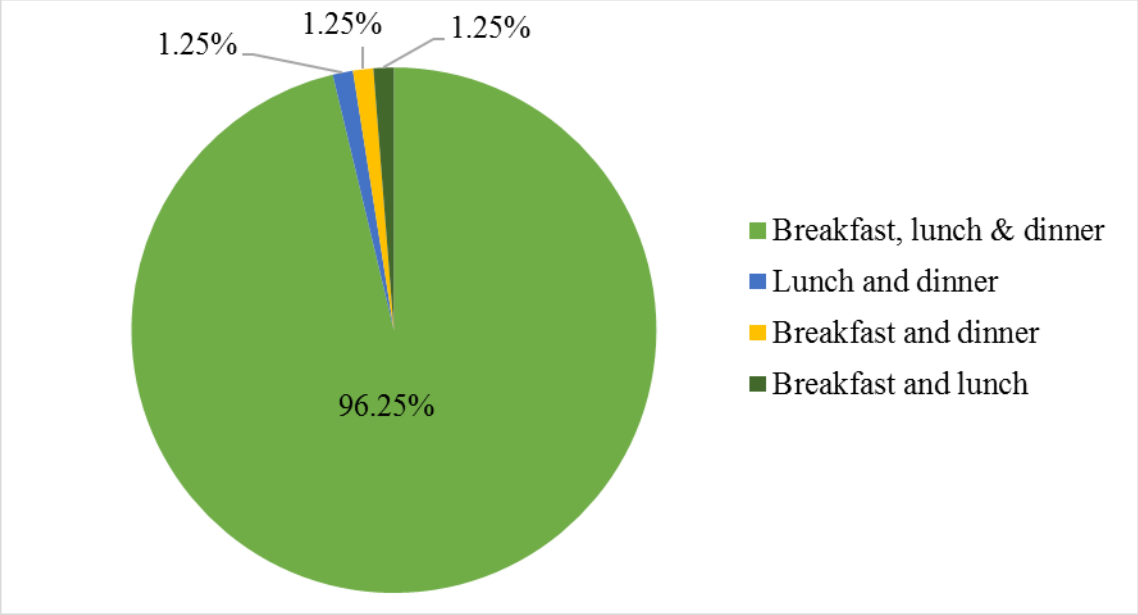

Figure 8: Number of meals per day

Although majority of households afforded to have three meals per day, still households' maize production in the study area was not enough to meet the food requirements of household members. Maize production from last season 2014/15 was not sufficient to satisfy the household food requirements till the next harvests as it can be noted that maize is the staple food crop. Sibhatu *et al.* (2015) suggested that, increasing farm produce is always conducive to household nutritional needs. But, Frelata *et al.* (2015) found that in Sub-Saharan African countries, consumption of self-produced food crops (by households) did not cover the food need for almost 80% of the households.

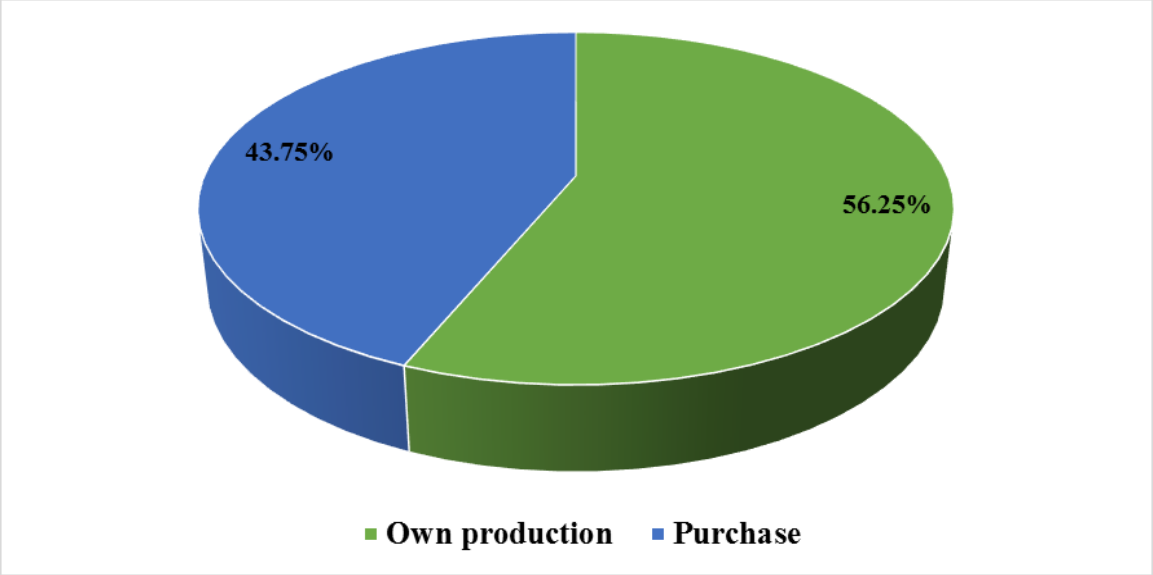

Figure 9: Source of maize consumed by households

4.5.2 Contribution of maize production towards household food security

Subsistence farming plays an important role in ensuring the availability of food at household level (Salami, 2010). The results in Table 13 indicate that at least three quarters (79.2%) of caloric intake per adult equivalent per day was acquired from maize. This suggests that, maize was the major food consumed by majority of households in the study area. The reason for this could be because, maize was the major food crop grown in the study area and majority of households cultivated it with the primary objective of meeting household food requirements. Usually, maize is consumed in the form of flour which is used to prepare a stiff porridge (*ugali* in Swahili) which is served most commonly with fried/boiled green vegetables, meat, fish or beans. Fresh maize is also boiled and consumed as a food.

Table 13: Caloric intake per adult equivalent per day

Type of food	Mean (kcal/adult equivalent/day)	Percentage proportional
Other food varieties	464.3	20.8
Maize	1770.1	79.2
Total	**2234.4**	**100**

Despite the importance of maize on per capita energy consumption, the results in Table 14 indicates that basing on dietary energy consumption (DEC) per adult equivalent (AE) per day, 53.75% of households were food secure and 46.25% were food insecure. The average DEC was 2,234.4 kcal per adult equivalent per day and the maximum and minimum values were 5,154.2 kcal and 1,029.86 kcal respectively per adult equivalent (AE) per day. This suggests that at least half of the households in the study area were food secure since they were above or equal to the minimum requirement of energy intake of 2,200 kcal per adult equivalent per day (Refer sub-section 3.6.2.3). The situation is alarming because the difference between food secure and insecure households is minimal (11.25%) and it can be said that almost half of the households in the study area were food insecure. The reason for this could be due to income constraint by many households especially individuals who were mostly relied on to feed the household. It becomes difficult for them to be able to purchase varieties of food on continuous basis that will help them acquire energy nutrients.

Table 14: Household food security status

Method used	Unit of measure	Food security status	Frequency
Basing on DEC per adult equivalent	kcal/adult equivalent/day	Food secure	43(53.75)
		Food insecure	37(46.25)
		Total	**80(100)**
Basing on household dietary diversity score (HDDS)	weighted sum score	Food secure	7(8.75)
		Food insecure	73(91.25)
		Total	**80(100)**

Figures in brackets indicates percentages

Other studies had similar results, like Abdalla (2014) who found a reduction in household daily caloric intake due to large household size in Sudan. Large household size reduces the ability of a household to acquire adequate energy intake due to high number of dependent members to few income earners within the household. In contrast, Orewa and Iyanbe (2010) conducted a study in rural Nigeria and found that household caloric acquisition increased with an increase in the number of household members.

Furthermore, any increase in household dietary diversity score (HDDS) reflects an improvement in the household's diet (Swindale and Bilinsky 2006). The cut-off point above and below 133.27 weighted sum determine adequate and inadequate food diversity respectively (Refer sub section 3.6.2.3).

The result based on dietary diversity (DD) showed that the average HDDS was 117.3 and the maximum and minimum scores were 149 and 87 respectively. Table 14 indicate the food security status in the study area basing on DD whereby, 73% of households were food insecure and only 7% were food secure. This suggests that, majority of households did not consume several varieties of food. This could be due to limited amount of income they had which constrained them from purchasing other types of foods. Limited amount of income among households in the study area could be influenced by low maize yield which forced them to allocate almost all of their produce on household food consumption than selling some portion for income generation. This is in line with Taruvinga *et al.* (2013) who found that, income had a great influence on moving from medium dietary diversity status to a high dietary diversity status in South Africa. Similarly, Snapp and Fisher (2015) found that, increased income from both agricultural and non-agricultural sources was critical to dietary diversity in Malawi.

4.6 Food Accessibility through Off-farm Income

Three quarters (70%) of household heads responded that at least one member in a household engaged in other non-farm activities for income generation either by being employed or self-employed. The most common occupations were small business (shop, fruit/vegetable vendor), driver (transportation), fishing, artisan (carpentry, mechanics, and bricklayer) and casual labour. Table 15 shows the average income gained by household members per month whereby, the maximum amount of income was 4,800,000 Tshs and the minimum amount was 30,000 Tshs. Household members with less than 100,000 Tshs per month were 3.75% but majority (33.75%) had an average income of between 100,001 Tshs and 200,000 Tshs. Despite that agriculture was the primary occupation for the majority of households, household members engaged in other

income generating activities to generate income because farming is not a full year work. Takane (2008) argues that, even though household members are working on household's own farm, they may also engage in other income generating activities so as to provide additional income to the household.

Some household heads/members used some amount of money acquired from maize sells and invest it in business or any small enterprise they engaged in. This was beneficial to farmers since it enabled them to have some funds to start with at the start of new production season (2015/16). Hence, farmers got the ability to conduct some initial farming activities like to buy maize seeds and paying labour wages during land preparation and planting of maize. In contrast, Aduba *et al.* (2013) argued that diversifying income from maize sales into other activities is not favourable because it will under develop the agriculture sector.

Apart from the fact that income gained from other activities helped farmers to have access to credit during the new production season, it was also helpful to them to have the ability to purchase other types of foods. Frelata *et al.* (2015) found off-farm income to be more important for households to access food in Sub-Saharan Africa. Arene and Anyaeji (2010) argues that households have greater chance of being food secure if a household head (or other household members) is/are engaged in other income generating activities; and according to Ngongi (2013) the production and access to food of high quality and quantity will increase with an increase in household income.

Table 15: Average income from non-farm activities (n=80)

Average income (TSHS)	Frequency	Percentage
<100,000	3	3.75
100,001 - 200,000	27	33.75
200,001 - 300,000	12	15
300,001 - 400,000	10	12.5
400,001 - 500,000	1	1.25
>500,001	3	3.75

4.7 Challenges Facing Maize Producers

Despite the importance of maize production in both household food security and income generation, maize producing households were faced with some constraints. The results in Figure 10 indicate the challenges faced maize producing households in the study area in which; 32.5% were constrained by low income. Low income restricted the ability of households to accommodate the expenses of using important inputs like fertilizer. In a FGD, the study revealed that in the study area, weeding is normally conducted twice in a production season; but due to financial constraints other households conducted once or vey late. This affected the output of their produce. Similarly, Aduba *et al.* (2013) found that, low income was a constraint among farmers in affording the expenses of farm inputs.

The results in Figure 10 show that 8.75% of maize producing households were affected by wilding animals particularly hippopotamus. Hippos mostly affected households in Bagara ward with their farms around Lake Babati by eating maize crops. During the interview one household head in Bagara ziwani said that, hippos destroyed almost a quarter of maize crops in his farm land of 1.5-acres. In dealing with this problem, farmers had to dig a trench around their farms so as to stop the hippos from entering the farm. Others had to stay in the farm during the night keep watching the crops.

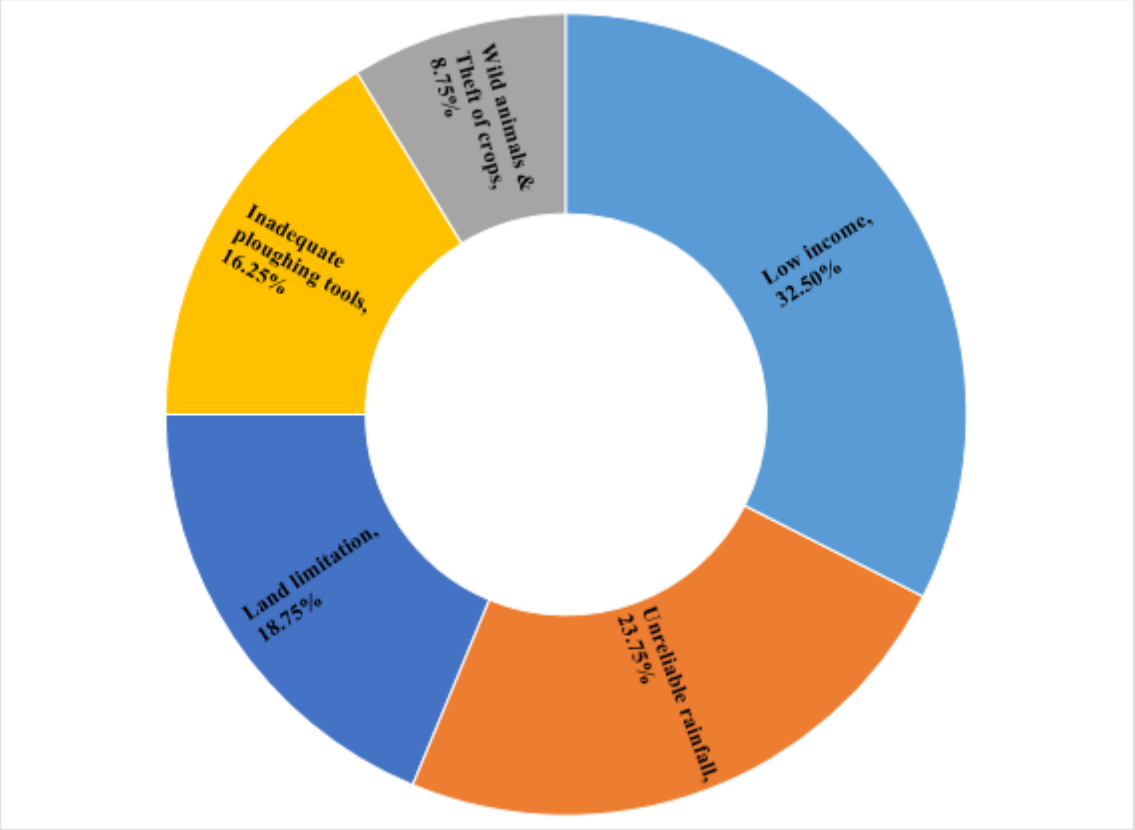

Figure 10: Challenges facing maize producers

Moreover, theft of maize crops was another challenge mentioned by household heads during the interview. They said that poverty and unemployment were the major influencing factors for crop theft; and additionally, majority of youth were not employed but they were mentally caught up by the demands of modern standard of living like wearing fashion clothes and buying phones (smart phones). However, during the survey, the study discovered that a large proportion of men were consuming local brew; this habit could also influence members within the household to steal maize so as to get quick money to meet their demand (buying brew). Likewise, Bunei *et al.* (2013) found that, crop theft was one of the major challenges facing farmers in Kenya; and it was influenced by poverty, youth unemployment and alcohol addiction among other factors. In addition to crop theft, alcohol addiction could also affect the supply and effectiveness of labour during important farm activities like weeding and harvesting since some household members in the study area were observed taking alcohol in the morning.

Leonardo *et al.* (2015) found that alcoholism influenced the poor quality of labour in Mozambique.

Other challenges mentioned by household heads were unreliable rainfall, land limitation and inadequate ploughing tools. Unreliable rainfall affects the growth of maize crops which ultimately affect maize yield; some households were constrained by small farms which resulted to low maize production; and due to inadequate farming tools like tractors and plough, farmers were compelled to queue for the equipment whereby some were ending up missing or access very late. Other studies have found high cost of labour, low access to extension services, absence of market for maize crops, high transportation costs, low soil fertility, poor quality of seeds and labour shortage among others, to be the major challenges facing maize producers in SSA (Aduba *et al.*, 2013; Dao *et al.*, 2015).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

5.1 Overview

This chapter presents the summary of the findings, conclusions and policy implications. It starts by highlighting the objectives of the study, the methodology used and the major observations of the study. Then, it provides conclusions concerning maize production in the study area and the general food security status in the study area. Finally, it suggests some recommendations as far as maize production and household food security is concerned; and delimitations of the study.

5.2 Summary of the Findings

Generally, the study was done so as to assess the contribution of smallholder maize production towards household food security in Babati District. The study examined household maize production per year; household caloric acquisition from maize; and challenges facing maize producers. It used a cross-sectional research design in acquiring information and purposive sampling was used to select a sample unit of households which comprised of 80 household heads as respondents. Interview, Focus Group Discussion and Observation were used as methods in data collection; and the tools used were questionnaire and checklist. Data processing was done through Statistical Package for Social Sciences (SPSS) version 20. Descriptive statistics was used in data analysis. Household caloric acquisition (HCA) was used to determine the number of calories acquired by households from maize consumption; household dietary diversity score (HDDS) and dietary energy consumed (DEC) were used to determine food security status.

Regarding the socio-economic characteristics of the respondents, the study found that 51.25%, 41.25% and 7.5% of household heads were in the age group of 20-39, 40-59 and 60+ respectively; but high proportion (21.3%) of household heads in the age group of 40-59 had maize production of more than 1000 kg. This implies that not only physical

ability but also experience in farming can influence maize production. A high (22.5%) proportion of MHHs had a maize production of more than 1000 kg compared to FHHs (10%). This can be due to low access to land and financial constraints faced by majority of women due to the nature of income generating activities they engaged to. Maize production by married household heads was higher than that of single household heads. This could be influenced by differences in responsibilities (burden of feeding the household) that a married household has and that of a single household head. Despite that majority (77.5%) of household heads had primary school education, having formal education contributed to an increased maize production enabling farmers to know the socioeconomic and environmental circumstances that leads their farming undertakings and understand easily the directives from extension officers. The average number of household size was 5.7 (approximately 6 members). Households with high number of individuals had a more maize production than those with low number of people. This can be due to differences in potential of labour power for farming between household with few individuals and those with many individuals.

The study also found other factors which influenced maize production in the study area which include land size and ownership, cropping system and the farming tolls used, the use of labour in farming activities. The result indicated that 80.75% of households cultivated a farm land of below 2 acres, implying that majority of households were subsistence farmers. A higher proportion (66.7%) of households with more than 3 acres produced more than 1000 kg of maize compared to 36% of households with less than 2 acres. It means that the size of the cultivated land influenced the quantity of maize produced among households. The study found that intercropping was dominant in the study area whereby, 70% of households preferred to intercrop maize with pigeon peas. Plough and hoe were the most used farming tools due to their affordability to the majority of farmers. About 49%, 24% and 7% of households used plough, tractor and hand hoe in land tilling. Among the households that used plough, 21.5% produced more than 1000 kg of maize. Again, 68.75% of households used hired labour for farming activities and 31.25% did not use. The reason for this could be due to financial

constraints, having a small farm or low crop production which did not require high number of labourers. The farm activities that were usually done manually through labour power include; planting, weeding and harvesting.

Moreover, the study found that 58.75%, 32.5% and 8.75% of households produced 100-1000 kg, more than 1000 kg and less than 100 kg respectively; the maximum and minimum production quantities were 3,500 kg and 0 kg. The maximum and minimum maize yields were 1500 kg/acre and 0 kg/acre; and the average maize yield was 509.72 kg/acre which is low compared to the national average yield of 641.64 kg/acre. This imply that the general maize production in the study area for 2014/15 season was low possibly due to insufficient rainfall; but there is a huge difference in maize production among households can be influenced by differences in land size, income and farm management practices.

The average production cost incurred by households was 118,642.29 Tshs per acre. Ploughing of the land and maize hybrid seeds accounted 41.91% and 30.44% of total production cost respectively. Fertilizer accounted the least production cost 3.23% due to low use of fertilizer among households. About 308.85 kg/acre and 1.06 kg/acre of organic fertilizer and inorganic fertilizer was used respectively. Maize production did not contribute much on household income because a high proportion (97.5%) of households consumed for food and only 33.75% of households which sold some proportion of maize they produced. Households accrued an average of 254,860.69 Tshs per acre and the average Return on Investment (ROI) was 44.1% meaning that, households earned 44.1% on costs per one acre of maize.

Almost all (96.25%) households were capable of having three meals per day. But 56.26% and 43.75% of households consumed maize from own production and market respectively. This implies that the harvest of the previous season was not enough to meet the household food requirements for the whole year. Households acquired an average amount of 1770.1 kcal/adult equivalent/day representing 79.2% of the total energy intake. This suggests that maize was the major food consumed by majority of

households in the study area. This could be because it was the most cultivated food crop in the study area. Basing on DEC 53.75% and 46.25% of households were food secure and insecure respectively. The average DEC was 2,234.4 kcal per adult equivalent per day and the maximum and minimum values were 5,154.2 kcal and 1,029.86 kcal respectively per adult equivalent (AE) per day. Also, basing on HDDS, 73% and 7% of households were food insecure and secure; suggesting that, majority of households did not consume several varieties of food.

Due to low contribution of maize on household income and food accessibility, three quarters (70%) of household heads responded that at least one individual in a household engaged in other off-farm activities. The common occupations reported by respondents were small business (shop, food/fruit/vegetable vendor), livestock keeping, driver (transportation), fishing, artisan (carpentry, mechanics, and bricklayer) and casual labour. The maximum and minimum amount of income was 4,800,000 Tshs and 30,000 Tshs respectively. About 32.5% of household heads responded that low income among maize producing households was the major challenge in maize production. It restricted the ability of households to accommodate the expenses of using important inputs like fertilizer. Other challenges mentioned were, unreliable rainfall (23.75%), land constraint (18.75%), inadequate ploughing tools (16.25%) and wild animals and crop theft (8.75%).

5.3 Conclusions

The findings of the study have indicated a low maize production which has been influenced by the differences in socio-economic characteristics of households and input usage among households. Fertilizers particularly manure/organic fertilizer was the farm input that was not utilised by majority of households despite its high accessibility simply because of transportation costs to the farms. Poor farm management among some households like late weeding has also contributed to low maize production since it has affected the growth of maize. Despite all these factors, insufficient rainfall played a great role in reducing the quantity of maize production.

Despite that there were households to whom food was available since the last harvest; it was not a guarantee that they acquired the needed calories from the foodstuffs they consumed. This is because the staple food consumed from one season to another was stiff porridge (*ugali).* Low maize yield ultimately affected household income from maize production; this also affected their ability to acquire the required calories from consumption of varieties of food. Inability to have access to different varieties of food affected the food security status for majority of households; and that most of them had a main challenge of consuming the nutritional diet so as to avoid the prevalence of malnutrition and food insecurity.

Households were mainly constrained by low income to invest in maize production; but unreliable rainfall remains as the major threat to majority of maize producing households in the study area. This is because farm practices in the study area rely highly on the amount of rainfall which ultimately affect maize yield. Hence, the study shows that, low maize yield affected the income accrued by households; also, farm income plays a great role for household's food security by enabling the accessibility and consumption of varieties of food.

5.4 Policy Implications

The study recommends the following basing on the findings and conclusions;

(i) Households should change their farming systems by expanding their small-scale farming to include the cultivation of vegetables, tubers and other legumes. This will enable them to have access to varieties of food and hence improve their nutritional intake.

(ii) Households should diversify their farm income sources to other off-farm activities so as to raise their incomes. This will enable them to access food in case of crop failure due to climatic conditions or crop diseases. This strategy will also enable them to have some capital that can help them to manage farm activities.

(iii) Apart from intercropping system of maize and pigeon peas, farmers should adopt the cultivation of other climate resistant crops like cassava and sorghum. This will ensure the availability of food varieties as well as an alternative source of food when other staple crops fail.

(iv) Extension officers at the local government level should provide technical advice through dissemination of information on climatic changes, selection of seeds and better farming methods to maintain soil fertility. This will help the farmers to make good decisions in their farming activities and hence increase the yields.

(v) Other stakeholders like Non-Governmental Organisations (NGOs) and Community Based Organisations (CBOs) based in Babati District should increase the number of farmer field schools and capacity building programmes to many farmers. This will impact new farming knowledge and skills to many farmers and hence help to improve maize production and other food crops production.

5.5 Delimitations of the Study

The study was conducted in Bagara ward only. This might have limited the ability to acquire more information on maize production and the state of food security in Babati District.

REFERENCES

Abdalla, S. (2014). Assessment of Caloric and Protein Intake in Sudan. Natural Resources, Agricultural Development and Food Security. International Working Paper Series. Paper 14/4.

Acharya, B. (2010). Questionnaire Design. A working paper. Training –cum Workshop in Research Methodology. 2-11 June 2010. Pulchok, Lalitpur, Nepal.

Achem, B. A., Mohammed, B.T., Aduba, J.J., Muhammad-Lawal, A. and Abdulquadri, F. (2013): A Comparative Assessment of the Profitability of Cassava Processing Enterprises in Kwara State, Nigeria. *Global Journal of Current Research. Vol. 1 No. 2. 2013. pp. 57-61.*

Aduba, J. J., Onojah, D. A., and Oladunni, O. A. (2013). Relationship between Farmers Socio-Economic Characteristics and Maize Production in Nigeria: The chasm. *Global Journal of Current Research. Vol. 1 No. 4. pp. 124-131.*

Agricultural sector output falls in Q3 of 2015. (2016, January 15). Daily News. Retrieved April 9, 2016 from World Wide Web http://www.dailynews.co.tz/index.php/business/46035-agricultural-sector-output falls-in-q3-of-2015

Arain, M., Campbell, M.J., Cooper, C. L. and Gillian Lancaster A. (2010). What Is a Pilot or Feasibility Study? A Review of Current Practice and Editorial Policy. *BMC Medical Research Methodology. Vol. 10. No. 67.*

Arene, C. J. and Anyaeji, C. R. (2010). Determinants of Food Security Among Households in Nsukka Metropolis of Enugu State, Nigeria. *Pakistan Journal of Social Sciences. Vol 30(1), pp. 9-16.*

Aslam, M. and Rasool, S. (2014). Investigating the Impact of Major Variables Influencing Food Security in Lahore, Pakistan. *International Journal on Advanced Science Engineering Information Technology. Vol.4 (3).*

Assa, M., Mehire, A., Ngoma, K., Magombo, E. and Gondwe, P. (2014). Determinants of Smallholder Farmers' Demand for Purchased Inputs in Lilongwe District, Malawi: Evidence from Mitundu Extension Planning Area. *Middle-East Journal of Scientific Research. Vol. 19. No. 10, pp. 1313-1318.*

Auma, J. O., Lagat, J. K. and Nagigi, M. W. (2010). A Comparison of Male-Female Household Headship and Agricultural Production in Marginal Areas of Rachuonyo and Homa Bay District, Kenya. *Jordan Journal of Agricultural Sciences, Volume 6, No.4.*

AusAID, (2011). Sustainable economic development: Improving food security. Retrieved October 18, 2015 from the World Wide Web: http://www.apec.org.au/docs/Supply%20Chain%20Risk%20Assurance/123_SCRA.pdf

Babati TC (2013). District Agricultural Report. Unpublished.

Babatunde, R. O., Omotosho, O. A., Ololunsanya, E. O. and Owoloki, G. M. (2008). Determinants of vulnerability to food insecurity: A gender analysis of farming household in Nigeria. *Journal of Agricultural Economics. Vol. 63 (1) pp.116 - 125.*

Baha, M., Temu A. and D. Philip (2013). Sources of Technical Efficiency Among Smallholders Maize Farmers in Babati District, Tanzania. *African Journal of Economic Review, Volume 1, Issue 2, July 2013.*

Bedemo, A., Getnet, K. and Kassa, B. (2013). Determinants of Household Demand for and Supply of Farm Labour in Rural Ethiopia. *Australian Journal of Labour Economics. Vol. 16. No. 3. pp 351 – 367.*

Beshir, B. and Wegary, D. (2014). Determinants of Smallholder Farmers' Hybrid Maize Adoption in The Drought Prone Central Rift Valley of Ethiopia. *African Journal of Agricultural Research. Vol. 9. No. 17, pp. 1334-1343.*

Bethelhem, K. and Stein, H. (2008). Difference in Maize Productivity Between Male-And Femaleheaded Households in Uganda. Ethiopian Development Research Institute. Addis Ababa, Ethiopia.

Boniphace, N. S., Fengying, N. and Chen, F. (2015). An Analysis of Smallholder Farmers' Socio-Economic Determinants for Inputs Use: A Case of Major Rice Producing Regions in Tanzania. *RJOAS, Vol. 2(38).*

Botchkarev, A. and Andru, P. (2011). A Return on Investment as a Metric for Evaluating Information Systems: Taxonomy and Application. *Interdisciplinary Journal of Information, Knowledge, and Management. Vol. 6.*

Bunei, E. K. and Rono, J. K. and Chessa, S. R. (2013). Factors Influencing Farm Crime in Kenya: Opinions and Experiences of Farmers. *International Journal of Rural Criminology. Vol. 2.*

Cairns, J. E., Hellin, J., Sonder K., Araus, J. L., MacRobert, J. F., *et al.*, (2013). Adapting Maize Production to Climate Change in Sub-Saharan Africa. *Food Security. Vol. 5. pp. 345–360.*

Caswell, J. A. and Yaktine, A. L. (2013). Supplemental Nutrition Assistance Program: Examining the Evidence to Define Benefit Adequacy. National Academy of Sciences. Washington DC. USA.

Cochrane, N. and D'Souza, A. (2015). Measuring Access to Food in Tanzania: A Food Basket Approach. United States Department of Agriculture. Economic Information Bulletin. No. 135.

Collier, P., S. Radwan, S. Wangwe and A. Wagner, (1990). Labour and poverty in Tanzania: Ujamaa and rural development in the United Republic of Tanzania. Oxford: Clarendon Press.

Coster, A. S. and Adeot, A. I. (2015). Economic Effects of Climate Change on Maize Production and Farmers' Adaptation Strategies in Nigeria: A Ricardian Approach. *Journal of Agricultural Science; Vol. 7, No. 5. pp. 67 – 84.*

Dania, S. O., Fagbola, O. and Alabi, R. A. (2014). The Yield and Farmer's Economic Advantage of Maize - Pigeon Pea Intercrop as Affected by The Application of Organic Base Fertilizer. *European Scientific Journal. Vol.10, No.25. pp. 1857 – 7881.*

Dao, A., Sanou J., Gracen, V. and. Danquah, E. Y. (2015). Indentifying Farmers' Preferences and Constraints to Maize Production in Two Agro-Ecological Zones in Burkina Faso. *Agriculture and Food Security Journal. Vol. 4. No. 13.*

Devereux, S. (2001). Sen's Entitlement Approach: Critiques and Counter-Critiques. *Oxford Development Studies, Vol. 29, No. 3.*

ESRF (2015). Tanzania Human Development Report 2014. Economic Transformation for Human Development. Dar es Salaam, Tanzania.

ESRF and ECDPM (2015). Assessment of Policy Coherence for Development for Food Security in Tanzania. Tanzania Food Security Profile.

Fanadzo, M., Chiduza, C., Mnkeni, P. N. S., van der Stoep, I. and Stevens, J. (2010). Crop production management practices as a cause for low water productivity at Zanyokwe Irrigation Scheme. *Water SA. Vol 36. No. 1. Pp. 27 – 36*. Retrieved April, 22 2016 from World Wide Web. http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S1816-79502010000100004&lng=en&tlng=en.

FAO (2006). Food Security. Policy Brief. Issue 2.

FAO (2008). An Introduction to the Basic Concepts of Food Security. EC - FAO Food Security Programme. Retrieved 2nd March, 2016 from World Wide Web www.foodsec.org

FAO (2008). Food Consumption Analysis Calculation and Use of the Food Consumption Score in Food Security Analysis. Rome, Italy.

FAO (2008a). The State of Food and Agriculture (SOFA) 2008 – Biofuels: Prospects, Risks and Opportunities. Food and Agriculture Organization of the United Nations. Rome.

FAO (2013). Guidelines for Measuring Household and Individual Dietary Diversity. Rome, Italy.

FAO (2015). Crop Water Information: Maize. FAO Water Development and Management Unit. Retrieved May 18, 2016 from World Wide Web http://www.fao.org/nr/water/cropinfo_maize.html.

FAO (2015). The State of Food Insecurity in the World. Meeting The 2015 International Hunger Targets: Taking Stock of Uneven Progress. Rome, Italy.

FAOSTAT (2015). Food and Agricultural Organization of the United Nations. FAO Statistical Database 2015. Retrieved 29/01/2016 from World Wide Web http://faostat3.fao.org/download/FB/CC/E.

Folayan, J. A (2013). Determinants of Post-Harvest Losses of Maize in Akure North Local Government Area of Ondo State, Nigeria. *Journal of Sustainable Society. Vol. 2, No. 1, pp.12-19.*

Frelata, R., Ridaurab, S. L., Gillerc, K. E., Herrerod, M., Douxchamps S., *et al.,* (2015). Drivers of Household Food Availability in Sub-Saharan Africa Based On Big Data from Small Farms. *Proceedings of the National Academy of Sciences Journal. Vol. 113. No. 2. Pp 458–463.*

Gerritsen, A (2011). Focus Group Discussion-Step-By Guide: Epic Result. University of Limpopo and VLIR Project South Africa.

Gross, R., Schoeneberger, H., Pfeifer, H. and Preuss H. A. (2000). The Four Dimensions of Food and Nutrition Security: Definitions and Concepts.

Haque, M. A., Moniruzzaman, M. S., Rahman, M. S. and Alam Q. M. (2012). Profitability of Hybrid Maize (Zea Mays L.) Seed Production Under Contract

Farming in Bangladesh: A Farm Level Study. *Bangladesh Journal of Agricultural Research. Vol. 37. No. 2. pp. 327-334.*

Hoddinott, J. (2002). Food Security in Practice. Methods for Rural Development Projects. IFPRI, Washington DC, USA.

Hofferth, S. L. (2003). Persistence and Change in The Food Security of Families with Children, 1997-1999. Department of Family Studies, University of Maryland. Retrieved May, 24 2016 from World Wide Web: http://naldc.nal.usda.gov/download/45674/PDF

IFAD (2013). Smallholders, Food Security and the Environment. Retrieved 12th January, 2016 from World Wide Web http://www.unep.org/pdf/SmallholderReport_WEB.pdf

IFPRI (1999). Choosing Outcome Indicators of Household Food Security. Washington D.C. USA.

IFPRI (2006). Smallholder Farming. Retrieved 20th January, 2016 from World Wide Web http://www.ifpri.org/topic/smallholder-farming.

IFPRI (2014). Global Hunger Index the Challenge of Hidden Hunger. Washington D.C. USA.

IFPRI (2015). Global Hunger Index: Armed Conflict and the Challenge of Hunger. Washington D.C. USA.

IGC (2016). Grain Market Report (GMR no. 467).

Julius, A. (2014). Factors Limiting Small-Scale Farmers' Access and Use of Tractors for Agricultural Mechanization in Abuja, North Central Zone, Nigeria. *European Journal of Sustainable Development. Vol. 3. No. 1. pp. 115-124.*

Kanu, B. H. (2000). Farm-Level Economic Benefits of Using Oxen for Ploughing and Weeding in Sierra Leone. Retrieved May 29, 2016 from World Wide Web

https://www.google.com/?gws_rd=ssl#q=FarmLevel+Economic+Benefits+of+Using+Oxen+for+Ploughing+and+Weeding+in+Sierra+Leone.

Karim, M. R. and Rahman, M. A. (2015). Drought Risk Management for Increased Cereal Production in Asian Least Developed Countries. *Weather and Climate Extremes Journal. Vol. 7. pp 24–35.*

Kearney, J. (2010). Food Consumption Trends and Drivers. *Philosophical Transactions of the Royal Society. Volume 365, Issue 1554.*

Khairo, S. (2009). Guide to Machinery Costs and Contract Rates. Prime Fact. No. 913.

Kibaara, B. W. and Kavoi, M.M. (2012). Application of Stochastic Frontier Approach Model to Assess Technical Efficiency in Kenya's Maize Production. *JAGST. Vol. 14(1). 20 pp.*

Kirkland, T., Kemp, R. S., Hunter, L. M. and Twine, W. S. (2013). Toward Improved Understanding of Food Security: A Methodological Examination Based in Rural South Africa. *Food Cult Soc. Journal. Vol. 16. No. 1. pp. 65–84.*

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques.* 2nd Ed. New Age International Publishers, New Delhi, India.

Kumba, J. K. (2015). The Role of Household Characteristics in Determining Food Security in Kisii Central Sub-County, Kenya. *Research on Humanities and Social Sciences. Vol. 5. pp. 2224-5766.*

Leonardo, W. J., Ven, G. W.J., Udo, H., Kanellopoulos, A. and Sitoe, A. *et al.,* (2015). Labour Not Land Constrains Agricultural Production and Food Self-Sufficiency in Maize-Based Smallholder Farming Systems in Mozambique. *Food Security Journal. Vol. 7.pp. 857–874.*

Li, Y. and Yu, W. (2010). Households Food Security in Poverty-Stricken Regions: Evidence from Western Rural China. *Agriculture and Agricultural Science Procedia 1. pp 386–395.*

Lukmanji, Z. and Hertzmark, E. (2008). Tanzania Food Composition Tables. Muhimbili University of Health and Allied Sciences (MUHAS), Dar es Salaam - Tanzania; Tanzania Food and Nutrition Centre (TFNC), Dar es Salaam - Tanzania; and Harvard School of Public Health (HSPH), Boston, USA. *259 pp.*

Makuvaro, V., Sue, W., Adelaide, M., Phillip, M. T., Cyril, *et al.,* (2014). An Overview of Current Agronomic Practices of Smallholder Farmers in Semi-Arid Central and Western Zimbabwe. *African Journal of Agricultural Research. Vol. 9 (35), pp. 2710-2720*.

Mashamaite, K. A. (2014). The Contributions of Smallholder Subsistence Agriculture Towards Rural Household Food Security in Maroteng Village, Limpopo Province. Unpublished Master dissertation, University of Limpopo.

Masvongo, J., Mutambara, J. and Zvinavashe, A. (2013). Viability of Tobacco Production Under Smallholder Farming Sector in Mount Darwin District, Zimbabwe. *Journal of Development and Agricultural Economics. Vol. 5(8), pp. 295-301*.

Matshe, I. (2009). Boosting Smallholder Production for Food Security. Some Approaches and Evidence from Studies in Sub-Saharan Africa. *Agrekon. Vol 48. No 4.*

Maxwell, D., Coates, J. and Vaitla, B. (2013). How Do Different Indicators of Household Food Security Compare? Empirical Evidence from Tigray. Feinstein International Center.

Mazunda, J. and Droppelmann, K. (2012). Maize Consumption Estimation and Dietary Diversity Assessment Methods in Malawi. IFPRI Policy Note.

McFarlane, B. and Garland, R. (1994). A Comparison of Mail and Face-to-Face Survey Methods: New Zealand Health Professionals. *Marketing Bulletin. Vol. 5. pp. 71-81*.

Minot, N., Epprecht, M., Anh, T. T. and Trung-Le, Q. (2006). Income Diversification and Poverty in the Northern Uplands of Vietnam. Research Report No. 145. Retrieved May, 13 2016 from World Wide Web http://www.ifpri.org/pubs/abstract/145/rr145ch06.pdf

Mtaki, B. (2016). 2016 Tanzania Corn, Wheat and Rice Report. United States Development Agency.

Muhihi, *et al.,* (2012). Perceptions, Facilitators, and Barriers to Consumption of Whole Grain Staple Foods among Overweight and Obese Tanzanian Adults: A Focus Group Study. *International Scholarly Research Network. Volume 2012, pp 7.*

Mulinga, N. (2013). Economic Analysis of Factors Affecting Technical Efficiency of Smallholders Maize Production on Rwanda. *Rwanda Journal, Series H: Economics and Management Vol. 1 No 1.*

Muna, M. M., Pypers, P., Mugendi, D., Kung'u J., Mugwe J., *et al.,* (2010). A Staggered Maize–Legume Intercrop Arrangement Robustly Increases Crop Yields and Economic Returns in The Highlands of Central Kenya. *Elsevier Journal. No. 115. Pp 132–139.*

Munodawafa, A. (2012). The Effect of Rainfall Characteristics and Tillage on Sheet Erosion and Maize Grain Yield in Semiarid Conditions and Granitic Sandy Soils of Zimbabwe. *Applied and Environmental Soil Science. Vol. 2012. 8 pp.*

Muoni, T., Rusinamhodzi, L. Thierfelder, C. (2013). Weed Control in Conservation Agriculture Systems of Zimbabwe: Identifying Economical Best Strategies. *Crop Protection Journal. Vol. 53. pp. 23 – 28.*

Murphy, S., Ruel, M. and Carriquiry A. (2012). Should Household Consumption and Expenditures Surveys (HCES) be used for nutritional assessment and planning? *Food and Nutrition Bulletin. Vol. 33. No. 3.*

Mutami, C. (2015). Smallholder Agriculture Production in Zimbabwe: A Survey. *The Journal of Sustainable Development Vol. 14, pp. 140-157.*

Muzari, W., Gatsi, W. and Muvhunzi, S. (2012). The Impacts of Technology Adoption on Smallholder Agricultural Productivity in Sub-Saharan Africa: A Review. *Journal of Sustainable Development. Vol. 5, No. 8.*

Ngongi, A. M. (2013). Food Insecurity and Coping Strategies of Farm Households in Kahama District, Tanzania. Unpublished Master dissertation, Sokoine University of Agriculture, Morogoro, Tanzania.

Ofwona, A. C. (2013). An Analysis of the Patterns of Food Consumption among Households in Kenya. *Journal of Emerging Trends in Economics and Management Sciences. Vol. 4(1) pp. 111-113.*

Okpachu, A. S., Okpachu, O. G. And Obijesi, I. K. (2014). The Impact of Education On Agricultural Productivity of Small Scale Rural Female Maize Farmers in Potiskum Local Government, Yobe State: A Panacea for Rural Economic Development in Nigeria. *International Journal of Research in Agriculture and Food Sciences. Vol. 2, No.4.*

Oladejo, J. A. and Adetunji, M.O. (2012). Economic Analysis of Maize (zea mays l.) Production in Oyo state of Nigeria. *Agricultural Science Research Journals. Vol. 2(2) pp. 77-83.*

Olaniyan, A. B. (2015). Maize: Panacea for Hunger in Nigeria. *African Journal of Plant Science. Vol. 9(3), pp. 155-174.*

Omovbude, S. and Udensi, E. U. (2012). Profitability of Selected Weed Control Methods in Maize (Zea Mays L.) In Nigeria. *Journal of Animal and Plant Sciences. Vol. 15, pp. 2109-2117*

Omoyo, N. Y., Wakhungu, J. and Oteng, S. (2015). Effects of Climate Variability On Maize Yield in The Arid and Semi-Arid Lands of Lower Eastern Kenya. *Agriculture and Food Security. Vol. 4. No. 8.*

Onasanya, O. A. and Obayelu O. A. (2016). Determinants of Food Security Status of Maize-Based Farming Households in Southern Guinea Savannah Area of Oyo

State, Nigeria. *Turkish Journal of Agriculture - Food Science and Technology. Vol. 4. No. 5. pp. 411-417.*

Oniang'o, R. K., Mutuku, J. M. and Malaba, S. J., (2003). Contemporary African Food Habits and Their Nutritional and Health Implications. *Asia Pacific J Clin Nutr.12 (3):231-236.*

Opaluwa, H. I., Ali, S. O. and Ukwuteno, S. O. (2015). Perception of the Constraints Affecting Maize Production in the Agricultural Zones of Kogi State, North Central, Nigeria. *Asian Journal of Agricultural Extension, Economics & Sociology. Vol. 7(2). pp. 1-6.*

Opara U. K. (2013). Perspective: The Evolving Dimensions and Perspectives On Food Security – What Are the Implications for Postharvest Technology Research, Policy and Practice? *International Journal Postharvest Technology and Innovation. Vol. 3. No. 3.*

Orewa, S. I. and Iyanbe, C. O. (2014). Household Food Insecurity in Nigeria: An Assessment of the Present Status of Protein – Energy Malnutrition among Rural and Low-income Urban Households. *Journal of Applied Sciences Research. Vol. 5. pp1615.*

Osugiri, I. I., Ugochukwu, A. I., Onyaguocha, S.U.O., Onyemauwa, C.S. and Ben-Chendo, G.N. (2012). Population Dynamics, Labour and Small-Holder Farmers' Productivity in Southeast Nigeria. *Journal of Economics and Sustainable Development. Vol.3, No.12.*

Otunge, D., Muchiri, N., Wachoro, G. and Kullaya, A. (2010). Mitigating the impact of drought in Tanzania: The WEMA intervention. Policy Brief.

Pérez-Escamilla, R. and Segall-Corrêa, A. M. (2008). Food Insecurity Measurement and Indicators. Revista de Nutrição. Vol. 21 (Supplement). pp. 15 – 26. Retrieved May 8, 2016 from World Wide Web

http://www.scielo.br/scielo.php?script=sci_arttext&pid=S141552732008000700003&lng=en&tlng=en.

Pieters, H., Guariso, A. and Vandeplas, A. (2013). Conceptual Framework for The Analysis of the Determinants of Food and Nutrition Security.

Pieters, H., Vandeplas, A., Guariso, A., Francken, N., Sarris, A., *et al.*, (2012). Perspectives on Relevant Concepts Related to Food and Nutrition Security. Working Paper 1.

Rana, I. A. and Khan, M. A (1985). Nutritional Quality of Maize, Sorghum and Millet. Presented at National Seminar on Maize, Sorghum and Millet. Islamabad.

Ranum, P. *et al.*, (2014). Global maize production, utilization, and consumption. *Annals of The New York Academy of Sciences 1312, pp 105-112.*

Regmi, A. and Meade, B. (2013). Demand Side Drivers of Global Food Security. *Global Food Security Journal. Vol. 2 pp.166–171.*

REPOA (2010). A Comparative Analysis of Poverty Incidence in Farming Systems of Tanzania. Retrieved May 23, 2015 from the World Wide Web: https://www.google.co.tz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CBwQFjAA&url=http%3A%2F%2Fwww.repoa.or.tz%2Fdocuments%2F104_web.pdf&ei=wK5dVbqsNvKs7Aaf3oKwCA&usg=AFQjCNG0U95HL_a9xlsGclAy1GMEstnwQ&sig2=8yMk1lPJUDFVZfYD26iT5g&bvm=bv.93756505,d.ZGU

REPOA (2011). Does Decentralised Forest Management Improve Livelihood of the Rural Community? Comparing Joint and Community Based Forest Management in Babati Tanzania. Presented at REPOA's 16th Annual Research Workshop. March 30-31. Dar es Salaam, Tanzania.

Sadiq, M.S. Yakasai, M.T. Ahmad, M.M. Lapkene T.Y. and Abubakar M. (2013). Profitability and Production Efficiency of Small-Scale Maize Production in Niger State, Nigeria. *IOSR Journal of Applied Physics. Volume 3. pp. 19-23.*

Salami, A., Kamara, A. B., and Brixiova, Z. (2010). Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities. Working Paper No. 105. African Development Bank. Ghana.

Schroeder, C., Onyango, K. T., Nar, B. R., Jick, N. A., Parzies, H. K. and Gemenet, D. C. (2013). Potentials of Hybrid Maize Varieties for Small-Holder Farmers in Kenya: A Review Based On Swot Analysis. *African Journal of Food Agriculture, Nutrition and Development. Vol. 13. No. 2. pp. 7562 – 7586.*

Sen, A. (1987). Hunger and Entitlements. World Institute for Development Economics Research, United Nations University.

Shiferaw, B., Prasanna B. M., Hellin, J. and Bänziger, M. (2011). Crops that Feed the World 6. Past Successes and Future Challenges to The Role Played by Maize in Global Food Security. *Food Security Journal. Vol. 3. pp. 307–327.*

Sibhatu, K. T., Krishna, V. V. and Qaim, M. (2015). Production Diversity and Dietary Diversity in Smallholder Farm Households. *Proceedings of the National Academy of Sciences Journal. Vol. 112. No. 34. Pp 10657–10662.*

Sims, B. and Kienzle, J. (2016). Making Mechanization Accessible to Smallholder Farmers in Sub-Saharan Africa. Retrieved June 9, 2016 from World Wide Web https://www.researchgate.net/publication/301536350_Making_Mechanization_Accessible_to_Smallholder_Farmers_in_Sub-Saharan_Africa

Singh, Y.K (2006). *Fundamentals of Research Methodology and Statistics.* New Age International (P) Ltd. India.

Smale, M. (2011). Does Household Headship Affect Demand for Hybrid Maize Seed in Kenya? Working Paper 115. MSU International Development.

Smale, M., Byerlee, D. and Jayne, T. (2011). Maize Revolutions in Sub-Saharan Africa. The World Bank. Agriculture and Rural Development. USA.

Snapp, S. S. and Fisher, M. (2015). Filling The Maize Basket Supports Crop Diversity and Quality of Household Diet in Malawi. *Food Security Journal. Vol 7. Pp. 83-96.*

Suleiman, R. A. and Rosentrater, K. A., (2015). Current Maize Production, Postharvest Losses and the Risk of Mycotoxins Contamination in Tanzania. Conference Proceedings and Presentations. New Orleans, Louisiana. July 26 – 29, 2015.

Swindale, A. and Bilinsky, P. (2006). Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (Vol .2). Food and Nutrition Technical Assistance Project. Academy for Educational Development. Washington, D.C.

Takane, T. (2008). Labor Use in Smallholder Agriculture in Malawi. *Six Village Case Studies. Vol 29(4). pp 183-200.*

Taruvinga, A., Muchenje, V. and Mushunje, A. (2013). Determinants of rural household dietary diversity: The case of Amatole and Nyandeni districts, South Africa. *International Journal of Development and Sustainability. Vol. 2. No 4.*

Tesfay, A., Amin, M. and Mulugeta, N. (2014). Management of Weeds in Maize (Zea mays L.) through Various Pre and Post Emergency Herbicides. *Advances in Crop Science and Technology Journal. Vol. 2. 5 pp.*

Teweldmehidin M. Y. and Conroy A. B (2010). The Economic Importance of Draught Oxen on Small Farms in Namibia's Eastern Caprivi Region. *African Journal of Agricultural Research Vol. 5(9), pp. 928-934.*

The Economist Intelligence Unit (2016). Global Food Security Index 2016. An Annual Measure of the State of Global Food Security. London, England.

Toit, D. C., Ramonyai, M. D., Lubbe, P. A. and Ntushelo, V. (2011). Food Security. Republic of South Africa. Department of Agriculture, Forestry and Fisheries.

Torero, M. (2014). Food security brings economic growth not the other way around. Retrieved September 27, 2015 from the World Wide Web

https://www.devex.com/news/food-security-brings-economic-growth-not-the-other-way-around-84561

Udoh, A. J. and Umoh, E. (2011). Fertilizer use and measures for increased sustainable consumption by peasant farmers: Food security approach in rural Nigeria. *ICRISAT Open Access Journal.*

Umar, S., Musa, M.W. and Kamsang, L. (2014). Determinants of Adoption of Improved Maize Varieties among Resource-Poor Households in Kano and Katsina States Nigeria. *Journal of Agricultural Extension. Vol.18 (2).*

Urassa, J. K. (2015). Factors Influencing Maize Crop Production at Household Levels: A case of Rukwa Region in the Southern Highlands of Tanzania. *African Journal of Agricultural Research. Vol 10 (10), pp.1097-1106.*

URT (2012). National Sample Census of Agriculture. 2007/2008 Small Holder Agriculture. Regional Report – Manyara Region (Volume Vu)

URT (2012). National Sample Census of Agriculture. Small Holder Agriculture. Crop Sector - National Report. Vol 2.

URT (2012). Tanzania. National Sample Census of Agriculture 2007/2008: Regional Reports.

URT (2013). The 2012 Population and Housing Census, Central Census Office, National Bureau of Statistics, President's Office, Planning Privatization. Dar es Salaam.

URT (2014). Statistical Abstract 2013. Ministry of Finance. Dar es Salaam.

URT (2016). Ministry of Agriculture Livestock and Fisheries. Agricultural Statistics. Retrieved February 27, 2016 from the World Wide Web: http://www.kilimo.go.tz/agricultural%20statistics/angricultural%20statistics.htm

Waldman, K. B., Attari, S. and Evans, T. (2016). The Impact of Farmers' Perceptions of Rainfall Uncertainty on Hybrid Maize Seed Choice. Retrieved June 1, 2016 from World Wide Web:

https://www.google.com/?gws_rd=ssl#q=costs+of+hybrid+seeds+in+sub-saharan+Africa&start=40

Wanmali, S. and Y. Islam, 2002. Food Security. In: The companion to development studies. London and Oxford University Press Inc. pp: 159 – 165.

World Bank (2014). Land and Food Security. Retrieved September 27, 2015 from the World Wide Web: https://www.worldbank.org/en/topic/agriculture/brief/land-and-food-security.

Yahya, P.H., and Xiaohui, Z. (2014). Constraints to Women Smallholder Farmers' Efforts in Ensuring Food Security at Household Level: A Case of Msowero Ward of Morogoro Region Tanzania. *International Journal of Economics and Finance; Vol. 6, No. 5; 2014.*

Yengoh, G. T. (2012). Determinants of yield differences in small-scale food crop farming systems in Cameroon. *Agriculture & Food Security. Vol 1. No. 19.*

Zalkuwi, J., Ibrahim A. and Kwakanapwa E. (2014). Analysis of Cost and Return of Maize Production in Numan Local Government Area of Adamawa State, Nigeria. *International Journal of Innovative Research and Development. Vol. 3. pp. 62-68.*

APPENDICES

Appendix 1: Caloric requirements by age and sex for East Africa

Age group	Sex	
	Male	Female
0 - 2	0.40	0.40
3-4	0.48	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.8	0.88
13 - 14	1.00	1.00
15 - 18	1.2	1.00
19 - 59	1.00	0.88
60+	0.88	0.72

Source: Source: Adopted from Collier *et al.* (1990)

Appendix 2: Household economies of scale constants in East Africa

Household Size	Marginal Cost	Average Cost
1	1.000	1.000
2	0.892	0.946
3	0.798	0.897
4	0.713	0.851
5	0.632	0.807
6	0.632	0.778
7	0.632	0.757
8	0.632	0.741
9	0.632	0.729
10 +	0.632	0.719

Source: Source: Adopted from Collier *et al.* (1990)

Appendix 3: Estimates for human requirement of proteins from maize

Age group	Reference protein (g/kg weight/day)		Maize (g/kg weight/day)	
3-6 months	1.85		3.19	
6-9 months	1.65		2.7	
9-12 months	1.5		2.46	
1-2 years	1.2		1.96	
3-5 years	1.1		1.8	
5-7 years	1		1.64	
	Male	Female	Male	Female
10-12 years	1	1	1.64	1.64
12-14 years	1	0.95	1.64	1.56
14-16	0.95	0.9	1.56	1.48
16-18 years	0.9	0.8	1.48	1.31
Adults	0.75	0.75	1.23	1.23
Pregnancy	+6			
Lactation	+13			

Source: Rana and Khan (1985)

Appendix 4: Energy content per 100 grams of edible portions, selected foods

Food type	Kcal	Food type	Kcal
Cereals		**Meat, poultry and sea foods**	
Maize, flour, dry	362	Beef, medium fat, cooked	323
Maize, green, cooked	246	Beef, boneless	267
Maize, cracked, cooked	119	Pork, medium fat, cooked	537
Maize, on the cob, immature	59	Goat meat	269
Bread, white	274	Chicken, raw	200
Wheat, flour, 72% extract	364	Egg, chicken	155
Millet, bulrush	361	Fish, dried, cod	368
Millet, finger, grain or flour	328	Fish, sardines	112
Rice, flour, local	366	**Starchy roots and tubers**	
Sorghum, flour	339	Cassava, dried	314
Legumes		Cassava, raw	160
Beans, kidney, mature seeds, raw	333	Potato, English, cooked	93
Pigeon peas, cooked	121	Sweet potato, fresh-AP	74
Pigeon peas, green	148	Sweet potato, orange, fresh-EP	103
Pigeon peas, raw	343	**Fruits**	
Vegetables		Banana, ripe	89
Cabbage, cooked	14	Mango, ripe, unripe, fresh-EP	65
Cabbage, raw, green, white	25	Orange, raw-AP	47
Cucumber, with peel, raw	15	Watermelon, raw	30
Hare lettuce, (mchunga)	10.7	Passion, fruit	43
Spinach, cooked	23	**Others**	
Sweet potato leaf	35	Sugar	387
Pumpkin leaf, raw	19	Chili powder, red	318
Tomato, bitter (African eggplant)	22	Ginger	66
Tomato, ripe, green	21	Honey	304
Milk		Sugarcane	26
Milk whole, 3.25% milk fat	60	Salt, iodized	0

Source: Lukmanji and Hertzmark (2008)

Appendix 5: Questionnaire for household heads

Introduction

My name is James Peter Ngurumwa. I am a master's student at Mzumbe University Morogoro pursuing MSc. Project Planning and Management. I am carrying an academic research entitled *Contribution of Smallholder Maize Production Towards Household Food Security in Babati District.* This is an academic study and I further wish to confirm to you that information you provide to this interview will be confidential. I am kindly asking for your cooperation during the interview session.

Date: ……..... Questionnaire No: …….

Ward: …….…… Village/Mtaa: ...…….

Please complete the following questionnaire by placing a tick [√] or filling in the appropriate box/space provided.

Part A: Personal information

Q1. Name of household head *(optional)*: ……..……

Q2. Age (years).

1. 20 - 24 [ ] 2. 25 – 29 [ ] 3. 30 – 34 [ ] 4. 35 – 39 [ ] 5. 40 - 44 [ ] 6. 45 – 49 [ ] 7. 50 – 54 [ ] 8. 55 – 59 [ ] 9. 60 – 64 [ ] 10. 65+ [ ]

Q3. Sex. 1. Male [ ] 2. Female [ ]

Q4. Marital Status.

1. Single [ ] 2. Married [ ] 3. Widow / Widower [ ] 4. Divorced / Separated [ ]

Q5. Highest level of education.

1. Primary school [ ] 2. Adult education [ ] 3. Secondary school [ ]
4. Tertiary education (College/University) [ ] 5. Not attended school [ ]

Q6. Family/household size

1. 1 – 2 [ ] 2. 3 – 4 [ ] 3. 5 – 6 [ ] 4. 7 - 8 [ ] 5. 9 -10 [ ]

Q7. What is the age structure of family/household members?

Age group	0-2	3-4	5-6	7-8	9-10	11-12	13-14	15-18	19-59	60+
Male										
Female										

Part B: Household's maize production & consumption

Q8. What types of food crops do you produce?

1.Maize [ ] 2.Pigeon peas *(mbaazi)* [ ] 3.Beans [ ] 4.Sorghum [ ] 4.Other crops *(specify)*……
……..

Q9. What is the size of the farm under cultivation? ……. acres.

Q10. What is the quantity of crops do you harvest in a normal year and their uses?

Food crop	Cultivated land (acres)	Production (kg)	Uses		
			Food (kg)	Sold (kg)	Other uses (kg)
Maize					
Pigeon peas					
Beans					
Sorghum					
Other crops *(specified)*					

*Assuming 1sack=100kg

Part C: Household food security status

Q11. I would like to ask you about the types of foods that were consumed by a household for the past 30 days (Place a one (1) in the box if anyone in the household ate the food in question, place a zero (0) in the box if no one in the household ate the food).

Food type		Frequency			
		J	M	S	R
Cereals	Ugali				
	Rice (milled)				
	Wheat flour/Bread				
Legume	Beans (dried)				
Vegetables	Green vegetables				
Meat, poultry and sea foods	Beef				
	Poultry				
	Fish				
	Sardine				
Starchy roots and tubers	Sweet potatoes				
Milk	Cow milk				
Sugars	Sugar				
Fruits	Bananas				
	Mangoes				
	Oranges				
	Other fruits				

Key: J=16-30 days S=4-15 days M=1-3 days R=0 days

Q12. I would like to ask you about the types of foods that were consumed by a household yesterday from the day to night. (Place a one (1) in the box if anyone in the household ate the food in question, place a zero (0) in the box if no one in the household ate the food).

Food type		Response	Quantity
Cereals	Ugali		
	Rice (milled)		
	Wheat flour/Bread		

Legume	Beans (dried)		
Vegetables	Green vegetables		
Meat, poultry and sea foods	Beef		
	Poultry		
	Fish		
	Sardine		
Starchy roots and tubers	Sweet potatoes		
Milk	Cow milk		
Sugars	Sugar		
Fruits	Bananas		
	Mangoes		
	Oranges		
	Other fruits		

Q13. What quantities of maize flour and rice were consumed in the last seven days?

Food	Quantity	Unit	Source
Maize flour			
Rice			

*Units: 1. bowl 2. sack 3. pot 4. kilogram

*Source: 1. Production 2. Purchase 3. Exchange 4. Donation/aid

Q14. Has your family reduced the number of meals since the last harvest due to insufficient food? 1.Yes [ ] 2.No [ ]

Q15. If Yes (Q12), which meal was reduced?

1.Breakfast [ ] 2.Lunch [ ] 3.Dinner [ ] 4.Breakfast & Lunch [ ] 5. Lunch & Dinner [ ]

Part E: Income accrued from maize production

Q16. What is the revenue generated from the sales of maize last season?

Quantity (kg)	Price (Tshs)

Q17. Which farming tool(s) did you use in land cultivation?

1.Tractor [ ] 2.Plough [ ] 3.Power tiller [ ] 4.Hand hoe [ ]

Q18. What are the costs incurred by applying these farming tools?

Activity	Cost (Tshs)		
	Tractor	**Plough/Ox cart**	**Power tiller**
Farm preparation			
Planting			
Weeding			
Harvesting			
Transportation			
Total			

Q19. Do you use fertilizer in maize production? 1. Yes [ ] 2.No [ ]

Organic (manure)		Inorganic	
Quantity (kg)	Cost (Tshs)	Quantity (kg)	Cost (Tshs)

Q20. What quantity of maize seeds did you purchase last season?

	Quantity	Cost (Tshs)
Maize seeds		

Q21. Do household members provide enough labour for maize production?

1.Yes [ ] 2.No [ ]

Q22. Do you use hired labour in maize production? 1.Yes [ ] 2.No [ ]

Q23. What labour costs did you incur in maize production during the last season?

Activity	No of labour	Cost (Tshs)
Farm preparation		
Planting		
Weeding		

Harvesting		
Transportation		
Total		

Q24. What is the household's source of income?

Source of income		Amount (Tshs)
Farm income	Crop income	
	Livestock income	
Off-farm income	Farm (labour/*kibarua*)	
	Non-farm	
Others *(specify, e.g pension, remittances)*		

Q25. Do any of household member engage in income generating activities?

1.Yes [ ] 2.No [ ]

Q26. If Yes (Q25), list the activities they do and income they earn in the table below.

S/no	**Activity**	**Income (Tshs/month)**
1.		
2.		
3.		
Total		

Q27. What are the challenges facing maize producing households in Babati?

i) …….

ii) …….

iii) …….

iv) …….

Thank you for your cooperation!

Appendix 6: Checklist for focus group discussion

Part A: Household maize production

1. What is the average farm size for households? What is the typical planting period for maize (month)?
2. What are the major food crops grown in your area? Which is the most important?
3. Which techniques do you use in maize production? (use of fertilizer, farming tools, hybrid seeds, intercropping, labour and farm management) Why?
4. What was the average cost of maize production per one-acre last season?
5. What is the average maize yield per acre in a normal season? What will it be this year? Which things affect maize yield?
6. Where do you sell the maize you produced? (directly to consumers/ to the market and sell to traders/to traders who visit you/ to the maize milling machines?) Why have you selected such marketing chain? What are the minimum and maximum prices for one bag of maize?
7. What types of labour opportunities do people have? Who does what? Do children work?

Part B: Food consumption pattern

1. Who is responsible to meet the household food needs?
2. What is the average number of meals consumed in a household? Who prepares these and how?
3. What types of foods usually consumed? Are their differences in diet between children, women and men? What are they?
4. Has there been any change in the people's diets since the last harvest? Since when and how? Why?
5. What do people do to meet their food needs in case of food shortage?

Concluding question: Apart from all the things we've discussed today, is there any other important issue relating to the topics that you would like to add?

Appendix 7: Checklist for agro-dealers

1. Is there any change in demand for agricultural inputs this season compared to other seasons? Why?
2. Which products are mostly in demand? Why? Are customers willing to pay for the allocated price?
3. Does the supply of inputs meet farmers' demand? If no, why?
4. Do farmers ask for technical advice after purchasing inputs?
5. Do you think farmers use the inputs as you/extension officer have instructed? If no, why?